POWER

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The Derelict Engineer

OUR correspondents have been discussing the derelict engineer.

There are derelicts in all trades and professions, men and machinery, ships and shops that have passed their days of usefulness.

Not because they are worn out and no longer capable of useful service, but because men and machinery and methods have come along better adapted to serve the purpose for which they were formerly employed.

A machine will depreciate with age and use. Care and attention, the timely renewal of wearing parts, the avoidance of strains will lengthen its term of service; but the time will come when increased upkeep, impaired efficiency or the availability of something better will send it to the scrap heap.

A man, on the other hand, up to the time of mental and physical disablement — and we are talking of derelict, not decrepit engineers— should improve with age and use.

There are limitations to the extent to which a machine can be speeded up, made over and adapted to changing conditions, but the right kind of man can keep himself qualified not only for changing service but ride onward and upward with the wave of progress.

The cutting of the coal cost of a kilowatt from five pounds to one pound per hour has not been done by men who would be put on the stocks because of a change in their jobs.

Some lines of business have gone on the rocks, leaving their trail of derelicts. Not so steam engineering.

There is hardly a line in which there has been such persistent increase in volume and complexity, such magnification both in extent and frequency of opportunity.

If the slow-speed sailing vessels have been beached, it is because high-powered craft are carrying their cargoes.

F. R. Low

The Philadelphia Electric Company Calibrates Its Meters

By FREDERIC G. ELY
Superintendent of Plant Efficiency, Philadelphia Electric Company

INACCURATE meters are worse than no meters at all. If they falsely indicate bad plant performance, either they are disregarded or else much effort and money are expended to improve matters. If they falsely indicate good performance, they lull the engineer into an unearned feeling of perfection in which large losses may be unsuspected. In either event money is lost. The only way to tell whether meters are right is to check them against a reliable standard instrument. Here is one excellent way of doing that.

THE Philadelphia Electric Company has installed in its Richmond Station an unusual apparatus for calibrating the various water meters used to obtain plant performance data. Essentially, it consists of a weir tank, with inlet piping to accommodate fluid meter orifices of different sizes, and a complement of instruments necessary to the measurement of flow by these two methods. Weir measurement is adopted as the standard and is made comparable to weighed water by the application of discharge coefficients determined from calibration tests of the weir equipment.[1]

The orifices, as used in the station piping systems, are made up between flanges of special test sections of pipe. For calibration, these test sections are transferred intact to a location in the test piping where the direction of flow corresponds to that of actual service. Reducing fittings and filler pieces are provided to adapt the various sizes of test sections to the 12-in. test piping, and an additional section of plain piping is available, for replacement in the service line while the orifice section is being calibrated.

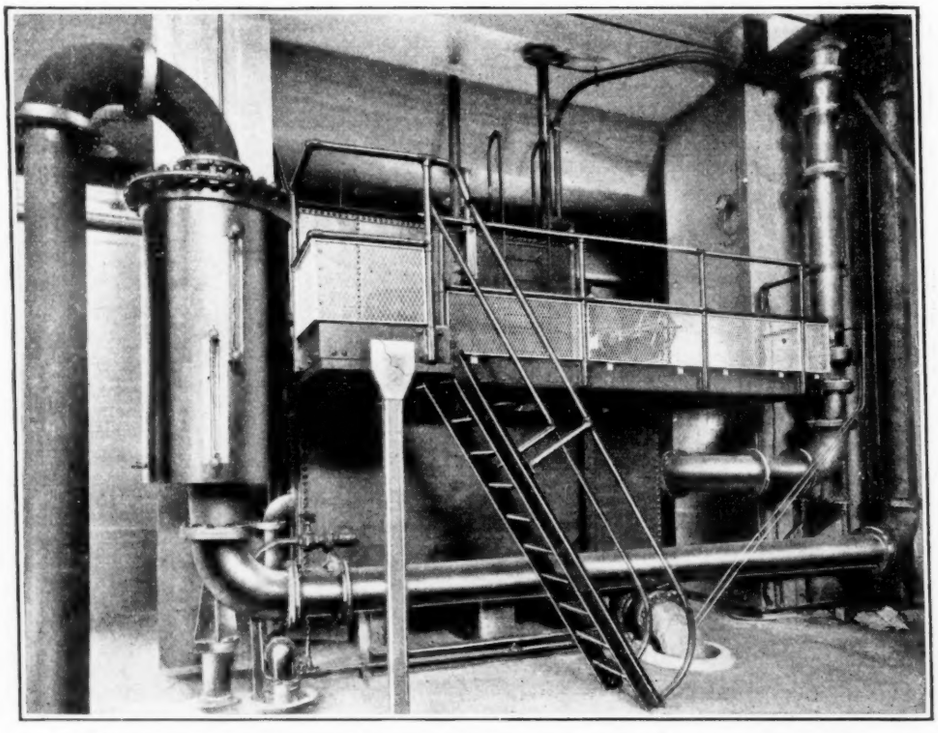

Fig. 1—This meter orifice calibrating outfit is in the corner of the turbine room of the Richmond Station

Two instruments are used for determination of the orifice indication of flow—a meter, similar in design to that with which the orifice normally functions, and a differential manometer, using mercury as the fluid medium. The latter instrument is of a special design, employing an inclined tube, which is set at such an angle that a deflection of the mercury column is equivalent to the same length of differential water head.

Both of these instruments are connected by sloping ½-in. piping to the leading and trailing taps in the orifice section and may conveniently be checked by means of vertical water columns attached to the system. Vent cocks are installed at all high points of the connecting piping for the liberation of entrapped air.

A high-speed clock is used in the meter to produce an extended record, which may be accurately planimetered.

The orifice section, after careful inspection, is installed in the desired location in the test piping, meter connections are properly made, and the weir most suitable for the range of the orifice is installed in the tank. Calibration checks are made of the meter and manometer by the water column method.

Zero correction for the external hook gage is made by the use of an auxiliary hook gage mounted close to the weir plate. This is adjusted by spirit level to the elevation of the weir apex, and then, by using a calm water surface at a level below the weir apex as a reference plane, the auxiliary and external hooks are set to the same elevation. Comparative readings of their scales serve to locate the zero of the external gage.

[1] See *Mechanical Engineering* for January, 1927, for report of calibration tests of the weir element.

Water is then circulated through the system, all air is vented from the piping, and the flow is adjusted to an arbitrary test value, as indicated by the meter record.

When conditions have become stable, instantaneous readings of head on the weir, from the hook gage, and differential head at the orifice, from the manometer, are taken at 15 sec. intervals for a period of approximately 10 min. Water temperature is observed.

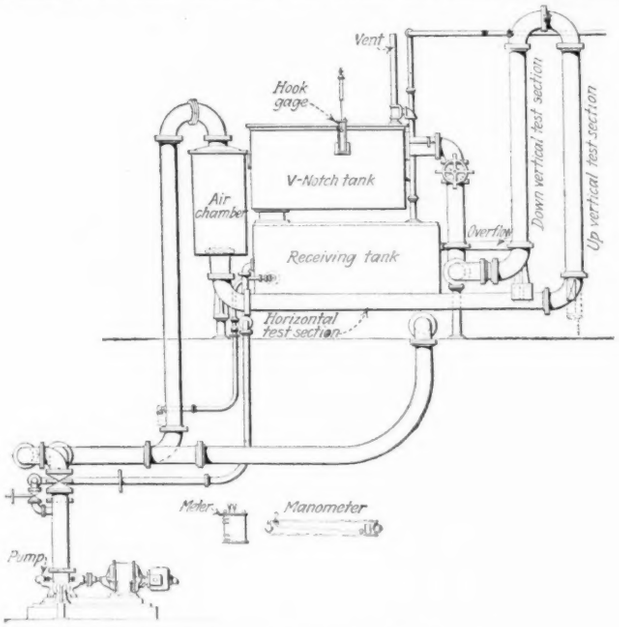

Fig. 2—Arrangement of test set

Water flow is produced by a two-speed motor-driven pump of 2,000 gal. per min. capacity, 119 ft. head and circulates through the air chamber, metering sections, weir tank and storage tank. Regulation is made at the two 12-in. gate valves, and at low rates of flow a 4-in. bypass line is used to relieve throttled conditions at the pump.

The flow is then altered to a different value and the procedure repeated until sufficient points have been obtained for a complete calibration.

Fig. 4 presents typical results from the apparatus. The points showing per cent orifice error form the key by which an orifice correction factor is determined.

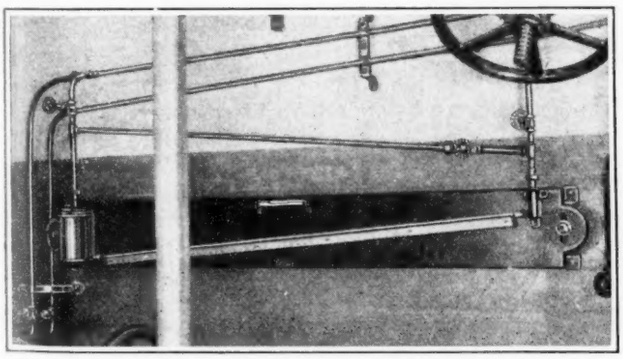

Fig. 3—The inclined mercury manometer measures the orifice head independently

These are calculated points and are plotted to such a scale that small discrepancies may be readily observed. The upper curve of total flow is plotted merely to show the general comparison of the two measurements.

Accurate flow measurement is, of course, the desired end of these investigations. While calibration values are determined essentially from comparison of the differential head produced by an orifice, with the actual weighed flow producing that head, several correction factors and instrument calibrations intervene between these fundamentals. It is therefore evident that considerable care must be exercised in conducting the tests.

However, in the opinion of those responsible for the installation of this apparatus, more importance is attached to high comparative accuracy in general plant metering than to extremely accurate measurements in isolated equipment tests. Calibration of orifices, by the method described, makes possible this result, with the elimination of weighing apparatus, extensive piping, etc.

Test runs are made with cold water, and temperature corrections are applied separately, for adaptation to service conditions. This method is felt to be more reliable than operation at higher temperatures, since it conforms to the condition under which the weirs were calibrated, and also the hook gage installation is best suited to measurement of cold water flow.

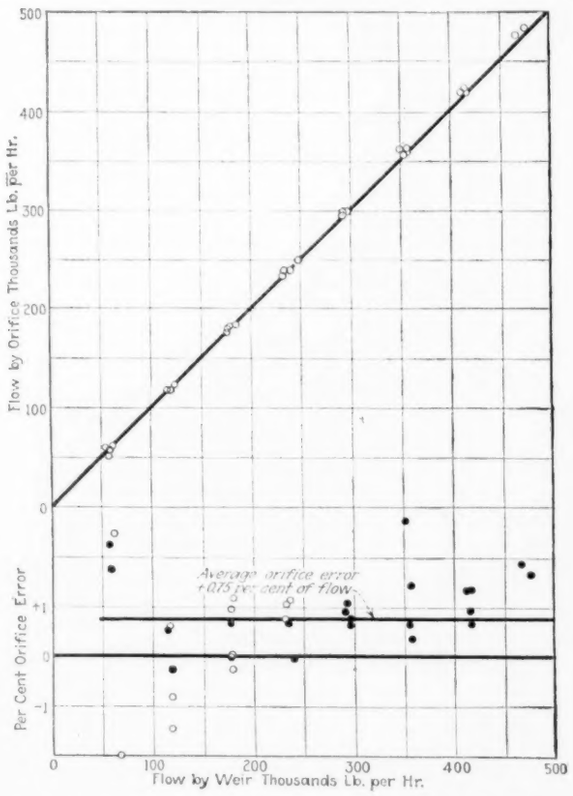

Fig. 4—Typical calibration curves for an orifice

It will be noted from Fig. 4, that a calibration value of constant percentage error has been adopted, which most nearly satisfies the points of the middle section of the range. This straight line is felt to be the true orifice characteristic, and the mid-range to be best suited to accurate measurement.

An installation similar to the one described, has been in use at the Delaware Station for several years. It is of lower capacity (90 deg. weir, 10-in. max. head) and therefore would not be adequate for the work required of the Richmond apparatus. This weir has never been checked directly against weighed water, but comparison of the two installations, drawn from a limited amount of data now available and obtained by checking identical orifices in the two test sets, indicates a close similarity of results.

Production and Use of Power in the Packing Industry*

By C. H. KANE†

IN DEALING with the power problem of the meat-packing industry, it is interesting to turn back some thirty to forty years and review the methods then existing for producing steam, power, light and refrigeration for its requirements. The facilities in those days consisted of a bank of hand-fired return-tubular boilers operated at low steam pressure and a number of belted, non-condensing engines located at various points about the plant. Occasionally, a belted generator driven from some lineshafting supplied a few scattered carbon filament incandescent lamps, but in most cases the oil lanterns and candles were made to suffice. Many miles of lineshafting, belts and rope drives distributed the power from the various engines, while the refrigeration for chilling the meat products was procured by harvesting and storing in large icehouses each winter, great quantities of natural ice. About 1890 saw the beginning of the end of those crude methods of producing power. Higher steam pressures and water-tube boilers with mechanical stokers replaced the hand-fired boilers. Compound condensing engines for driving electric generators and ammonia compressors producing mechanical refrigeration, and electric transmission with individual motor drive or group of drives, resulted in substantial savings in labor and fuel and better yields in product.

WHILE the demand for large quantities of hot water takes up much of the available low-pressure exhaust, some of the processes require steam at higher pressure. Lack of balance between refrigeration, pumping, heating and process demands limits the advantages of steam generation at very high pressure. Under certain conditions purchased power in combination with privately generated power, and employment of dual drive for seasonal use, has proved most economical.

In a few cases turbines have found their way into the power production, but generally speaking, the character of the operations and the lack of a sufficient supply of condensing water eliminated the turbine as an important factor. As the industry requires great quantities of both cold and hot water, the heating of this water as well as the heating of the buildings and a large part of the processing may be done by low-pressure steam, thus giving efficient use for the exhaust steam from a great many of the pumps and prime movers.

A factor helpful in the economical production of steam was a change in the method of rendering and processing. In the past the open contact or so-called wet process, with steam at 40 or 50 lb. pressure coming into direct contact with the product, had been used. In recent years a gradual change has been made to the dry process in which the heat from the steam is absorbed by the product in jacketed kettles, melters or driers. The new method is more economical as the condensate that heretofore had been entirely lost may be returned to the boilers.

To return the condensate in the case of the compound condensing engines would require the substitution of surface-type condensers for the barometric condensers in use. This is hardly feasible in view of the lack of a suitable supply of condensing water, as the packing plant depends almost entirely upon cooling water by circulating over cooling towers.

Good thermal efficiencies in the use of exhaust steam have been shown where the demand can be balanced properly with the supply. Boiler-feed temperatures up to 225 deg. F. are obtained as the heaters are operated in parallel with the exhaust steam system carrying a pressure of about 5 lb. gage. Because of the low pressure in the exhaust-steam system, the usage in the processes is limited, so that considerable thought has been given to the possibilities of generating steam at higher pressures for the operation of power-driven units, refrigerating machines, pumps, etc., with the idea of exhausting at pressures up to 150 lb., to bring the entire requirements of the packing plant steam processing within the scope of the exhaust-steam system. Such a system, however, is confronted with the difficulty of bringing the requirements of processing and heating which occur about eight hours a day in balance with the refrigerating machines, pumps and portions of the manufacturing load that are required over the 24-hour day. The overhead and fixed investments are increased, but where the packing plant is so located that it must look forward to the economical production of its own steam and power, the plan has encouraging possibilities.

Comparing this method of operating with the plan of generating steam at lower pressures for processing and the purchase of central-station service for power requirements, where modern central-station service and schedules are available, it has been found by Swift & Company that the balance is in favor of using the central-station service.

Electrification of the present refrigerating machines will be encouraged with the development by electrical manufacturers of slow-speed synchronous motors, within reasonable investment costs, from 500 to 1,200 hp. in size, operating at a speed of about 60 r.p.m. In Chicago there is about a 6,000-hp. load of this character and

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†Manager, Construction Department, Swift & Co.

similar loads on a smaller scale in all of the large plants of the company.

In late years a number of medium-speed refrigerating machines developing from 400 to 500 tons of refrigeration have been installed with a dual drive, consisting of a cross-compound Corliss engine and a synchronous motor on the mainshaft replacing the flywheel. By dropping the connecting rods and the valve gear rods on the cross-compound engine, the compressor may be operated satisfactorily by the motor. During the winter months it is easy to pick up the connecting rods and the valve gear of the steam engine and thus have available the exhaust steam. From the point of view of duplicate power this is a nice unit, as either machine can take the load in case of accident. It represents high initial investment, however, and is justifiable only where a low power rate is available.

Throughout the manufacturing process there is a great variety of machines and equipment requiring power, many invented and built by the packers for their special purposes. Motors driving these various machines, ranging in size from 1 to 150 hp., are mostly of the constant-speed type, although in a number of cases variable-speed motors are used, as in the case of the dressing chains, filling machines, printing machinery, fans and pumps.

The refrigerating load creates the greatest demand for power, being a 24-hour load with the maximum demand coming in the summer months and the minimum in the winter, although the reduction is not so great as might be anticipated, as the heavy livestock receipts begin in October and continue well along through the winter. Motor requirements for refrigerating purposes will range from 100 to 1,000 hp., depending on the size of the unit. The auxiliaries, such as water circulating pumps for the ammonia condensers and brine circulating pumps, where brine is used as a medium for distributing the refrigeration to the various coolers, are driven with motors of the high-speed induction type and may be run fully loaded at a maximum power factor of 92 per cent, most of the year.

In plants where the central-station rates have not as yet reached a scale that will justify the replacement of the compound condensing engines with motors, the load has been split to the extent of circulating all the condensing water and the brine by means of motors.

At the Chicago plant of Swift & Co. the total power represented by refrigerating, pumping, electrical drives for manufacturing, etc., will aggregate some 30,000 hp., divided as follows:

Steam-driven refrigerating machines.	8,000 hp.
Combined steam-driven and electric-driven pumping equipment.....	5,000 hp.
Electric power produced by plant.....	3,000 hp.
Electric power supplied by central station	12,000 hp.

The electric station is equipped to generate some 6,000 kw., and the agreement with the central station provides that the plant be operated during the peak period. In other words, it is considered a part of the central-station stand-by power, and during the fall and winter months it is operated in parallel with the service. During December last the plant operated on peaks over a period of two hours a day several days during the month. The generators are driven by simple twin Corliss engines exhausting into a common header that serves both the exhaust-steam supply and an exhaust-steam turbine of about 3,500 kw. capacity. The twin Corliss engine unit generates about 2,500 kw. and functions when the demand for exhaust steam exceeds the supply. The two units in combination—that is, the engine and the low-pressure turbine—supply current to the central station and are subject to their demand, being arranged to run in parallel with central-station service, as previously explained.

In almost every plant, whether the water is obtained from the city or from wells, pumping is necessary. There are few cases where the city mains are of sufficient size or carry sufficient pressure to deliver the water for the various operations, so that booster pumps are required. In pumping water from wells ranging in depth to 250 ft., vertical turbine pumps driven by motors are used. In some locations, however, wells are driven to a depth of 600 to 2,000 ft. and in some cases 3,000 ft. Delivery of water to the surface is effected by an air-lift system in which two-stage compressors, driven by medium-speed synchronous motors, have been found to be satisfactory operating units.

Electricity Used in Processes

In the manufacture of shortenings vegetable oils are solidified by a hydrogen treatment. The large quantity of hydrogen required is obtained by electrolytic dissociation of water. Direct current at 120 volts is passed through a series of cells requiring 2.2 volts each, the amount of current ranging from 400 to 600 amperes, depending upon the size of the cells. The electrolyte is caustic potash, and hydrogen is collected at the cathodes and oxygen at the anodes. The oxygen thus produced as a byproduct is compressed into drums and sold, principally to the metal trades for cutting and welding. To produce the direct current two generators of 750 kw. each are driven by 2,200-volt synchronous motors, operating at 100 per cent power factor and 100 per cent load factor. The capacity of the plant is 100,000 cu.ft. of hydrogen and 50,000 cu.ft. of oxygen daily, using 15,000 kw. capacity throughout the 24-hour day.

In certain cases where the conditions warrant, electricity is used for heating and thawing. When it is figured that the cost per thousand B.t.u. in steam generated in a fairly economical boiler by coal in comparison with the cost of B.t.u. generated by electric heating is in the ratio of about one to six, the use of electricity for the foregoing purposes does not appear economical. Nevertheless, to convey steam through one-half to one mile of insulated piping exposed to the elements, and finally deliver it to a certain point for heating water, or to an isolated office in the midst of a cold-storage building, is a problem that also has disadvantages. The heat units cannot be snapped off and on at will as with electric current, nor can the supply be controlled with the same degree of simplicity.

For much the same reasons experiments are going on with an electric element located within a tank car or an electric heater in close proximity to the tank car for the melting of oil, lard and other liquids that are conveyed in great quantities to a central refining and manufacturing plant where they are distributed from the tank cars into proper receptacles in the plant. While the electricity costs more per 1,000 B.t.u. for the heat than would be the case for the steam coils that have been in use, the new method greatly reduces the time element and standby loss, saves labor and expedites the operation of the tank cars.

Carbon-Dioxide Used To Extinguish Fires in Electrical Equipment

By CHARLES C. C. RAGSDALE

A GREAT many methods have been developed for putting out fires in electrical equipment. Recently, carbon-dioxide has been given considerable attention for this purpose, and this article describes the application of such apparatus.

AS THE units in modern power plants become larger, the necessity for protecting them from damage commands increasing attention of the engineer. Elaborate systems of relays and switches serve to preserve the continuity of service on the lines from a power plant. Electrical protection on all kinds of equipment is provided. But that most ancient bugaboo of the human race, fire, stands ready to do its disastrous work at many places in a power plant. It must be checked at once, or its spread will quickly cause serious trouble.

One might ask what there is in a modern fireproof power plant which can burn, outside of the coal or oil under the boilers. The answer is, the insulation on all conductors, or at least that part which contains carbon and hydrogen compounds, and the oil in the large transformers and switches. These combustibles are in proximity with the current-carrying copper, which is the source of heat sufficient to cause fire at times of short-circuits or continued overloads.

Methods of Extinguishing Fires

The methods of extinguishing a fire in electrical equipment vary considerably. Water is the best-known medium for quickly putting out an ordinary fire and reducing the temperature of the combustibles. But water as a remedy for fire in electrical machines is almost as bad as the disease, as the equipment must be thoroughly dried out before it is again put in service. Carbon-tetrachloride has been suggested to replace water, and while it evaporates quickly and leaves the machine dry, it is an excellent solvent and the insulating compounds may be hopelessly damaged in this way. The introduction of an inert gas to smother the flame is probably the ideal method. Steam may be regarded as such a medium, but it is potentially liquid water and has all the objections of water. Perhaps the cheapest, most harmless, and still effective gas that may be used is carbon-dioxide.

United States laws provide for steam piping for smothering fires in cargo holds of vessels. To avoid the consequent damage to cargo when steam is thus used, many steamships have installed a carbon-dioxide fire-extinguishing system for primary use with the steam still available in an emergency and to comply with the law. The great volume of a ship's hold requires a large number of tanks of carbon dioxide, and this has partly retarded its general adoption. Since the volume of a compartment in a power plant may be made relatively small where fires are likely to occur, it becomes economically practicable to install carbon-dioxide tanks and piping to these small areas for the smothering of fire.

In principle the system consists of a battery of tanks of compressed carbon-dioxide, connected by pipes to compartments and housing of electrical equipment in which fire may occur. In use the main valves at the tanks are opened, releasing the inert gas to the pipe lines. The proper valve in the pipe lines is then opened to admit the carbon-dioxide to that compartment where it is needed.

Fig. 1 shows five tanks ready for operation. The tanks are mounted on the platform of a scale, the beam of which may be seen at the left, and carries an electric contact which closes when the beam goes down. After the tanks are in place, the beam is balanced with the sliding weight. If there is any leakage of gas, the load on the platform becomes less, the beam falls and closes the contact, which will cause a bell to ring or give a signal to the power-plant operator, thus warning him of the fire-fighting equipment's condition.

Under normal conditions there is no pressure in the pipe lines. The apparatus under pressure consists only of the tanks and their valves. When carbon dioxide

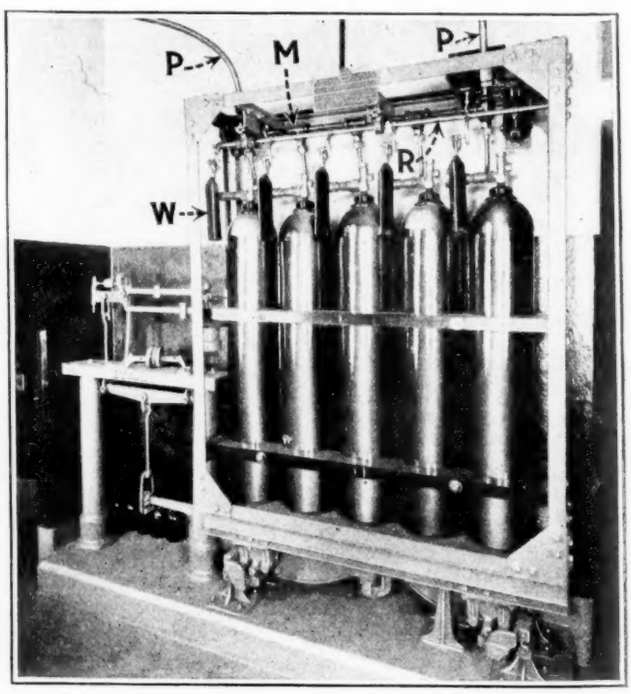


Fig. 1—Fire-extinguishing supply tanks are mounted on a scale

as a gas under high pressure is slowly released through a small opening, as when an ordinary valve is partly opened, the gas cools upon expanding to atmospheric pressure. The cooling is sufficient to reduce part of the released gas to the solid form. If the gas is released rapidly from a tank, this freezing does not occur.

The tanks in the picture have valves that open quickly and wide. Each valve consists of a disk of thin metal

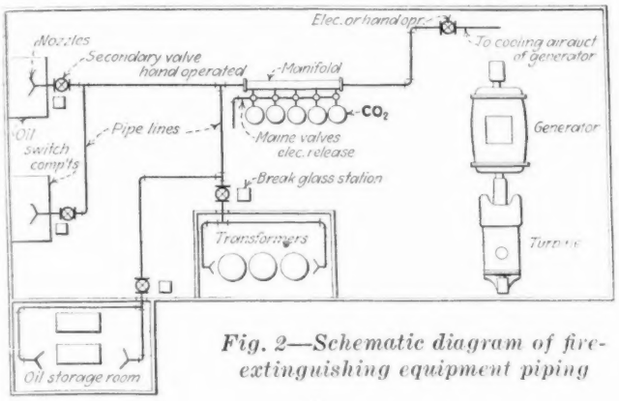


Fig. 2—Schematic diagram of fire-extinguishing equipment piping

which is cut away when released, just as a tin can is cut open with a can opener. In the upper right-hand corner of the framework around the tanks is the electric coil for releasing the tanks. When this coil is energized, it causes the rod *R* to rotate, which lifts the fingers holding the five prism-shaped weights *W*. This allows the weights to fall, and in falling they turn the cutters within the valves and release the contents of the five tanks simultaneously into the manifold *M*. Two distributing pipes *P* lead to different parts of the power plant.

The piping to the desired points in the power plant is usually about one-and-one-half inch double-extra-heavy iron. This may be laid out similar to that shown in Fig. 2. In all cases the secondary valve is placed outside of the room containing the fire hazard in order that a man, upon discovering fire in the room where he may be, first gets out to a safe point himself and then turns on the carbon dioxode. Near each secondary valve is a break-glass station which electrically releases the main valves at the tanks when the glass is broken, in a manner similar to a fire-alarm box.

The end of the pipe is provided with two nozzles, usually monel metal, which are simply two pipe caps with a hole about three-eighths inch diameter in the top. These nozzles are pointed in a horizontal direction and at various heights above the floor. Carbon dioxide is heavier than air, and the nozzles are preferably located a foot or two above the floor in order that the gas may flood the room, forcing the air out of an opening near the top. This opening is provided with an electric fan which is turned on after the fire is out and serves to remove smoke and the carbon dioxide from the compartment so that it may be entered for inspection. These compartments are not necessarily airtight. An ordinary door closes tightly enough to prevent excessive leakage of carbon dioxide. It is not necessary that the atmosphere consist of 100 per cent carbon dioxide to smother a fire. Experiments show that a proportion of only 25 per cent carbon dioxide in air is sufficient to put out a fire at once.

Where Fires Are Likely To Occur

Fire in a power plant is likely to occur at any one of four places: In the generators, that is, the insulation on the windings; in oil-switch compartments; in the transformers; and in the oil storage room. Of these four the generator is provided with the most elaborate protection.

The newer and larger generators are all of the totally inclosed type. This greatly reduces the noise from the machines and allows a positive control of the temperature of the machines by forced air cooling. Temperature coils are located at several places in the generator windings. These indicate the temperatures of these locations on an indicating millivoltmeter calibrated in degrees of temperature. While these instruments serve well to indicate the general temperature of the machine, they are inadequate as a fire alarm, because a fire may occur at some part of the winding quite a distance from the temperature coils. A more positive and automatic system must be used for fire alarm and fire fighting.

There is now on the market a photo-electric cell with a relay system used to indicate smoke in stacks. A beam of light is directed toward the cell, and the relays remain in position until the light is cut off or even partly diminished. Such a light and cell may be installed in the air duct coming from the generator, and the first trace of smoke from burning insulation would trip the relays and release carbon dioxide into the generator. As this protection should be full-automatic, the secondary valve in the carbon-dioxide pipe line to the generator should be electrically operated as well as

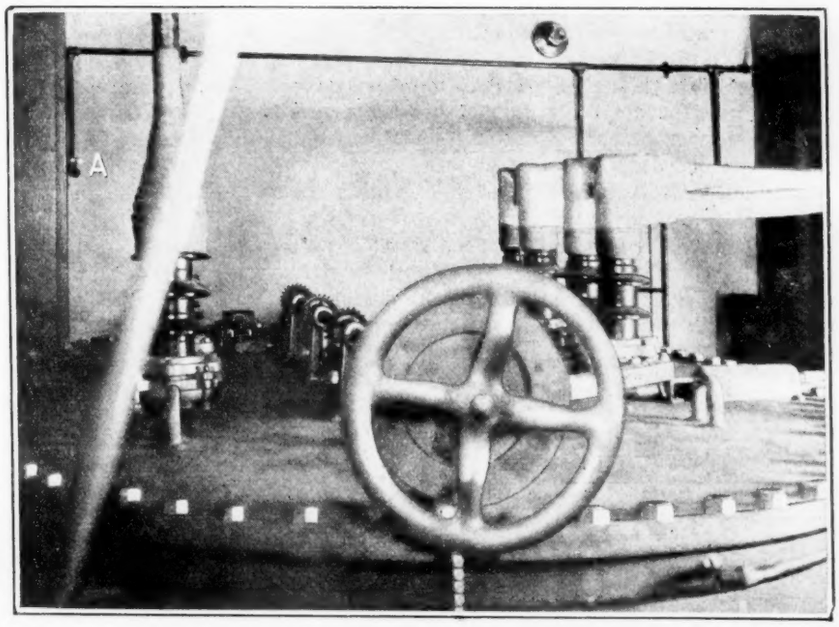


Fig. 3—Carbon-dioxide pipes and nozzles located near the top of a three-phase transformer

the main valve. Simultaneously with the release of the carbon dioxide, the relays may automatically open the main switch to the machine, shut off the steam to the driving turbine, ring an alarm and light an alarm lamp mounted on top of the generator to indicate which of several machines in the plant is in trouble.

In case the insulation breaks down and the winding of the machine becomes grounded, fire is likely to result, as the windings heat up at a rapid rate. To wait for the smoke indicator to operate or for the engineer or operator to discover the fire, would be too late to save the machine from serious damage. Accordingly, what is known as differential protection is resorted to. This is not installed as a part of the carbon dioxide fire-fighting system, but the one makes use of the other.

One might think that fire in a generator would automatically be extinguished by smothering from its own products of combustion. Experiments have shown that in many installations, even with totally inclosed generators there is sufficient air leakage to maintain combustion. The fanning action of air has put out flames in the end turns of the winding, but the burning of glowing carbon was increased and continued to do damage. The introduction of carbon-dioxide extinguishes the flame and glowing carbon almost immediately.

A switch compartment fire is usually more easily handled than a generator fire. Here the chief combustible is the oil in the tank inclosing the switch. This is sometimes ignited by the heat liberated when the switch opens at times of short-circuit on the line.

The transformer-room protection may be a little more elaborate, some of the generator protection methods being applicable here, notably the differential protection. In transformers carbon-dioxide cannot be used effectively in the cooling system as with the generator. The gas is usually sprayed into the room near the tops of the transformers. Fig. 3 shows the carbon-dioxide pipes and nozzles on the far wall; one of the nozzles is at *A*. The transformer is of the three-phase type. The high-voltage bushings are on the left and the low voltage on the right. The four bushings on the low-voltage side have three for the phase wires, the fourth being the neutral. The large wheel in the foreground and the gears immediately behind are for changing the internal taps on the transformer for voltage adjustments.

Fuel Oil Situation in the Central States*

By CAMPBELL OSBORN†

DURING the last several years there has been a marked change in the economic position of fuel oil in the United States. In former years nearly all the gas oil and the residual oil obtained as byproducts in the fractional distillation of crude petroleum for gasoline was consumed for fuel. Later, the demand for gasoline increased more rapidly than the production of crude oil and it became impossible to obtain enough gasoline by this method; the price of gasoline rose; wide differentials prevailed between fuel oil and gasoline; and the refineries, finding it both feasible and profitable to crack fuel oil for the gasoline content, installed equipment for this purpose to the extent that one-third of the nation's gasoline requirements is now obtained from fuel oil. This change in the practice of refining has brought about a lower ultimate yield of marketed fuel oil per barrel of petroleum charged to stills, a new type of fuel known as "cracked fuel oil" and a higher price.

The study presented in the paper is made for the purpose of measuring these changes and, on the basis of data available, of roughly gaging the future trend of the supply, uses and prices of fuel oil, with particular reference to the central part of the United States.

In its engineering sense the term "fuel oil" comprises gas oil (the fraction below kerosene in gravity), the residual oil that remains after the gasoline and kerosene have been removed by fractional distillation, and low-grade crude oil containing relatively small fractions of light products. Gas oil and residual fuel oil represent the major part of the total.

Uses of fuel oil in the United States are widely ramified. Probably, the largest use is made by oil companies for cracking and for fuel under stills and boilers and in Diesel engines for refinery, lease, and pipeline operations. Cracking requirements for fuel oil are expanding probably more rapidly than the other uses. The railroads serving the Southwestern States are large consumers. The artificial gas plants and the Diesel power installations consume much gas oil and light fuel oil, and a few industries, especially steel, glass, clay, porcelain and lumber, are limited consumers of fuel oil. Within the last few years there has been a growing use of fuel oil and gas oil for heating private residences and office buildings.

From the beginning of 1924 to the last quarter of 1926 the average spot price of fuel oil at refineries in the central part of the country rose from 70c. to nearly $1.40 per barrel. The yield of gasoline, including skimming, cracking and blending, increased from 45 to 50 per cent, and that of fuel oil declined from 45 to 35 per cent per barrel. In spite of these changes, however, stocks of fuel oil, now amounting to about 11,000,000 bbl., have increased slightly, and the current supply, though somewhat lower in 1926 than in 1925, has been maintained fairly well. The latter now amounts to about 280,000 bbl. per day. The decline in yield per barrel of crude oil has thus far been offset nearly by increased runs to stills.

Future Prospects

There has been much loose thinking and talking in recent years with reference to the future production and price of both crude oil and fuel oil. Each year predictions are made that the peak of petroleum production has passed and that the time is close at hand when fuel oil will be so high in price that it can no

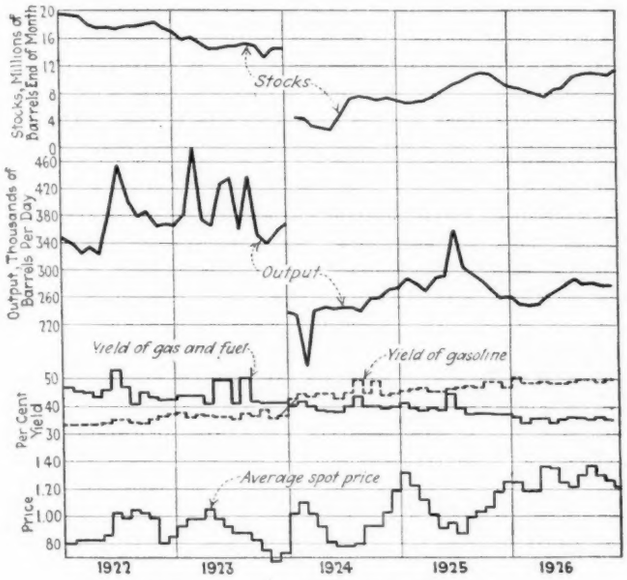
*Abstract of paper presented before the Midwest Power Conference, Chicago, Feb. 18, 1927.

†Economist to the president of Marland Oil Company.

longer compete with coal. It is the author's feeling that the output in 1927, on the basis of present prices, will exceed that of 1926; that the peak production may be determined ultimately by the peak demand; and that the time may be many years ahead. The untested, possible oil land of this country is far too great in area, and the improved methods of finding and producing oil are much too promising to permit of alarm with reference to a shortage of crude oil. The next step lies in the direction of more efficient production and use, and this, in the author's judgment, is the best means of conservation.

Effect of Cracking

One of the major problems of the petroleum industry and the consumer is to determine how far cracking will proceed before fuel oil will compete equally with gasoline on a price basis. A New York petroleum engineer estimates that this will take place when a total



Gas and fuel oil in the Midwest

Comprising the United States exclusive of California, East Coast and West Coast areas. The Gulf Coast figures are not available separately prior to 1924 and are included in the Midwest for 1922 and 1923.

yield of 42.5 per cent of gasoline by combined cracking, skimming and blending methods is reached, and at this point the inefficient use of fuel oil will vanish. In 1926 the national yield was 37.5 per cent. It is higher in the Mid-Continent because of the high gravity of the crude oil. At the present rate of increase, 42.5 per cent would be reached in two years. The author's analysis indicates that the point referred to may not be reached until the national gasoline yield is 46.4 per cent, meaning that at the present rate of growth in cracking, the industry would reach this figure by 1930. The total United States supply of fuel oil produced in 1925 was 460,000,000 bbl. If this entire amount were subjected to cracking under present practice, there would be a loss in the process of extracting the gasoline amounting to 8.7 per cent, or roughly 40,000,000 bbl., which would consist of gas and coke. The quantity of fuel oil consumed in the United States in 1925 for the superior uses, exclusive of cracked gasoline, was 228,000,000 bbl. If this amount of fuel oil, plus the loss referred to, be deducted from the total supply, there would be a remainder of 192,000,000 bbl. of gasoline.

It is appreciated that many power plants now using fuel oil could not at this time readily handle cracked fuel oil, but under the stress of necessity burners probably would be redesigned so as to feed it in a satisfactory manner. The figure cited is not given as the ultimate end of cracking, for further improvements are to be anticipated in the cracking processes which will develop a higher yield of gasoline than is now realized.

Conclusions Summarized

Summarizing, the outstanding conclusions of this investigation are as follows:

There probably will be no drastic change in the supply of fuel oil for efficient users in the Central States during the next several years. Increased runs to stills are expected to offset decreased yields per barrel of crude. It may be necessary to improve burners so that they will satisfactorily and efficiently burn cracked fuel oil, and to install more Diesel engines. It is uneconomic to burn fuel oil directly in competition with coal on a purely B.t.u. basis, and the use for this purpose will be reduced.

Cracking will further increase, but not so rapidly as in some other parts of the country. It is felt that most of the fuel oil currently produced in the Mid-Continent is being subjected to cracking.

The consumption of oil in Diesel engines will increase despite a rise in price. The Diesel engine is one of the most economic sources of power from oil.

During the recent past the railroads have met their increased requirements for oil by increasing efficiency. It is doubtful whether the volume they use will again increase except under the stimulus of over-production. The Diesel electric-driven locomotive now in the experimental stage may some day become a substantial consumer of fuel oil.

The artificial gas plants can now probably compete equally with gasoline buyers for their requirements.

The use of fuel oil for heating homes and office buildings will increase, because the commodity is largely bought on the basis of conveninece, for which the public is willing to pay. This expansion will be slow at first and will depend upon the education of the consumer, further improvements and standardization of burners, and better service after installation.

The use of fuel oil to generate steam for heat and power in inland industries other than railroads is declining.

With a stable crude supply prices of fuel oil are expected to further slowly increase until cracking has proceeded to the point in the United States that the total yield of gasoline exceeds 45 per cent.

Light and Power Industry in Canada—The electric light and power industry now ranks first among Canadian manufacturing industries in terms of capitalization, with an aggregate amounting to more than $700,000,000, and sixth among the industries in terms of annual gross revenue. As the present installation represents the development of only 10 per cent of the recorded water-power resources, and since the rate of construction of new turbines has been increasing in the last few years, there is every indication that in the immediate future the industry will witness an expansion well in line with the present trend. During 1926 the production of electrical energy in Canada increased 23.8 per cent over that of 1925.

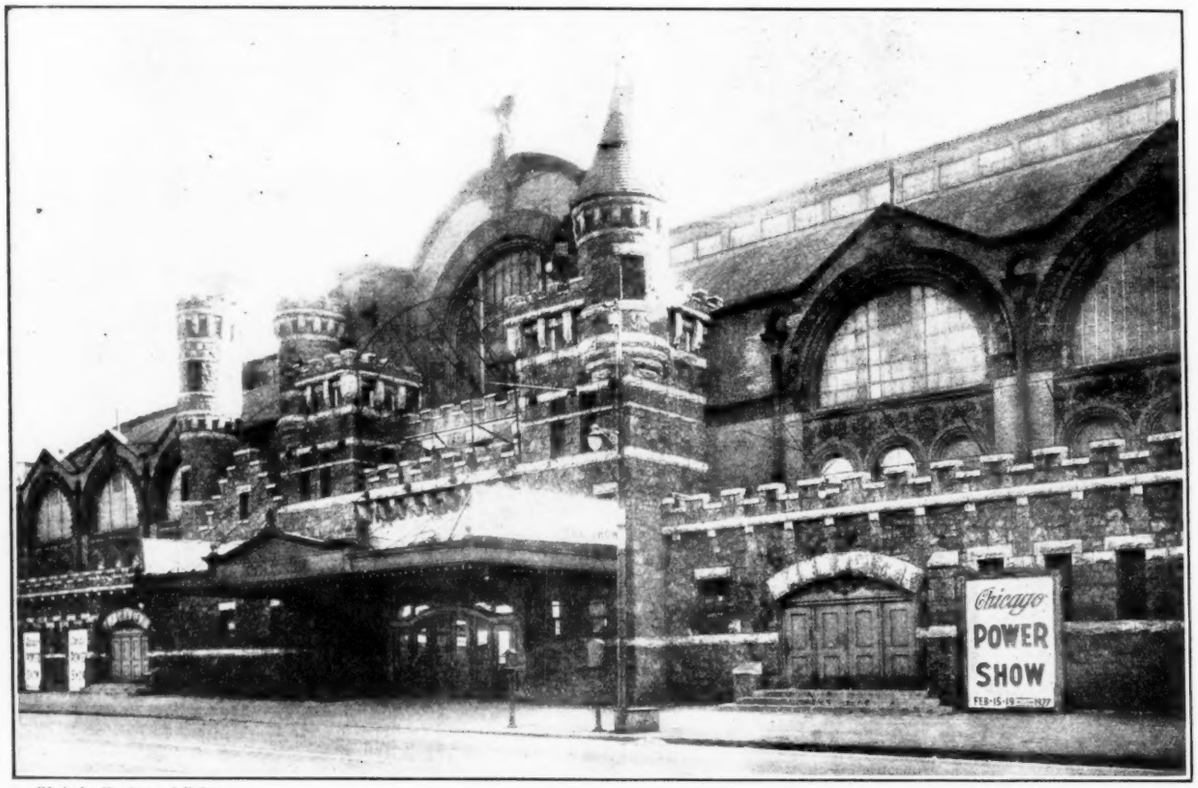


Photo by Kaufman & Fabry.

Second Chicago Power Show a Big Success

Last Year's Efforts Surpassed in Number and Quality of Exhibits—Attractiveness of the Exhibits and Large Showing of Commercial Units a Feature

AS MENTIONED in a previous issue, when the Power Show was inaugurated at Chicago a year ago, some doubts were expressed as to the advisability of holding a show of this kind, in view of a similar exposition, the New York Power Show, being already well established. But the success that attended the first Chicago show was beyond all expectation and indicated clearly the need for one in the Middle West. As a result it was decided at that time to hold the show again this year. The second power show, which was held in the Coliseum Feb. 15 to 19, far surpassed in every detail that of a year ago. The number of exhibitors increased about 40 per cent and the attendance in about the same proportion.

Although the Chicago show has not as yet attained the proportions of the New York show, it was comprehensive to say the least and was entirely representative of the complete line of power-plant equipment. In fact it would be difficult to mention any piece of equipment designed to promote efficiency in the development and utilization of power that was not included among the exhibits. The Coliseum proved an ideal place for the show, as it permitted all the exhibits to be placed on one floor with liberal aisle space. The Midwest Power Conference was held during the same week in the same building.

The large showing of commercial sized units, the attractiveness of the booths and the large number of new developments were some of the outstanding features of the exposition. In many instances not only were complete units shown, but cut-away sections or partly assembled machines were added, so that the principles of construction and operation might be more readily understood. The principal exhibits comprised equipment in which there has been recent active development to meet the demands of the power plant brought about by the trend in certain lines and the conditions imposed by the higher steam pressures now being adopted.

Viewing the exhibition as a whole, the boiler plant was the part of the power house that was very much in evidence from meters, valves and refractories to the larger equipment included coal handling and weighing equipment, boilers, stokers, pulverized-coal equipment of both the storage and unit types, air and water-cooled furnace walls, combustion-control apparatus and forced- and induced-draft equipment. Other parts of the power plant were by no means neglected, turbine- and motor-driven auxiliaries such as exciter units, high-pressure

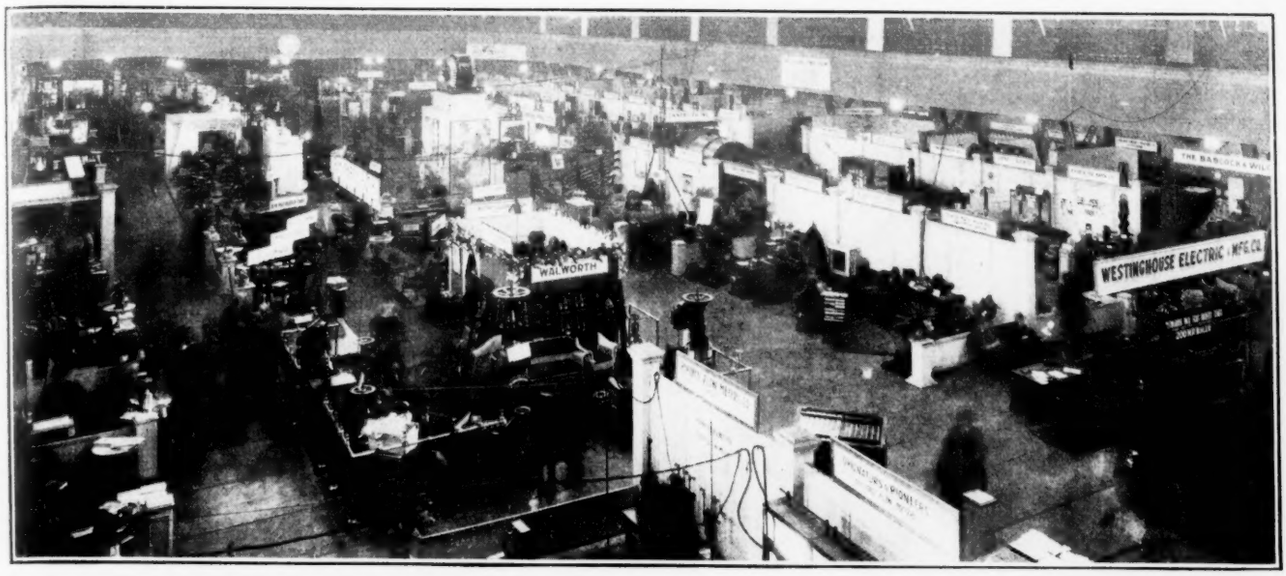


Photo by Kaufman & Fabry.

feed pumps, centrifugal pumps for various services were numerous, also steam-jet air pumps and turbine and transformer oil purifying apparatus. Even the electrical end of the station came in for considerable attention. One company showed, in addition to switching gear, voltage regulators and transformers, a 1,500-kw. mercury arc rectifier having a direct-current output of 1,000 amperes at 1,500 volts. Other companies showed transformer safety cutouts, circuit breakers, measuring instruments, valve controls and motor-control equipment. Briefly, it might be said that the exposition gave an excellent idea of the present status of the art and presented a general picture of progress and development.

The impossibility, within practical space limitations, of describing all the exhibits has made it necessary to pass over those that are standard equipment and refer more in detail to new equipment and improvements recently introduced into the field.

The high ratings at which boilers are now being operated and the opportunities for increasing materially the capacity of boilers at present installed caused much interest to center around the pulverized-coal apparatus and the air- and water-cooled furnace walls and refractories. While there was nothing distinctly new included in the exhibits of pulverized-fuel apparatus, mention might be made of the Calumet burner exhibited by the Fuller-Lehigh Co. and the combination burner for pulverized coal, gas and oil shown by the Peabody Engineering Co. For descriptions and illustrations of these burners the reader is referred to the Jan. 4, 1927, and the Jan. 18, 1927, issues respectively. In addition to the companies mentioned, no less than six other manufacturers exhibited unit pulverizers and burners.

Some engineers have expressed the opinion that the advent of pulverized fuel equipment has sounded the

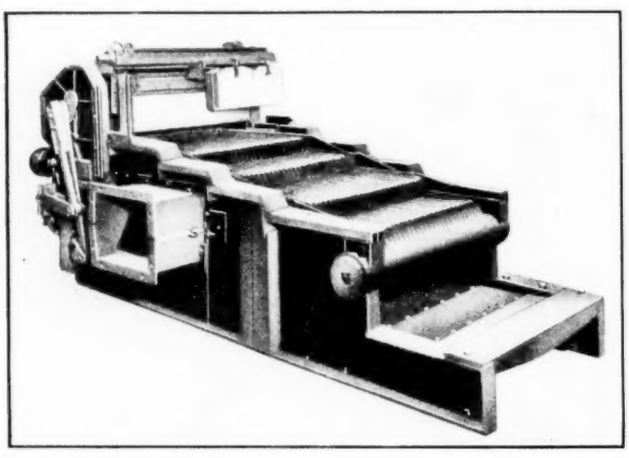


Fig. 1—View of new Harrington stoker

death knell of the mechanical stoker. But no less than three new stokers were found at the show, two of which are designed especially for burning the cheaper grades of fuels. One of the new ones was the Auburn heavy-duty stoker, which is being built in the semi- and full-mechanical types and for use with natural or forced draft. A complete description of this stoker appeared in the Feb. 22 issue.

Another stoker of the full mechanical type was the "King Coal" developed by the well-known stoker designer, Joseph Harrington. This is designed especially for small power boilers, being built in sizes from 18 to 54 sq.ft. It is a front, overfeed stepped-grate mechanism having two stationary and two movable grate sections. The feed plate is a combination section, forming the bottom of the feed hopper as well as the first of the four grate sections. The rear end of the movable section rests and slides on a stationary section. The reciprocating motion of the two sections causes the coal to work along to the ash plate and tends to keep the fuel bed thoroughly aërated. At the rear end of

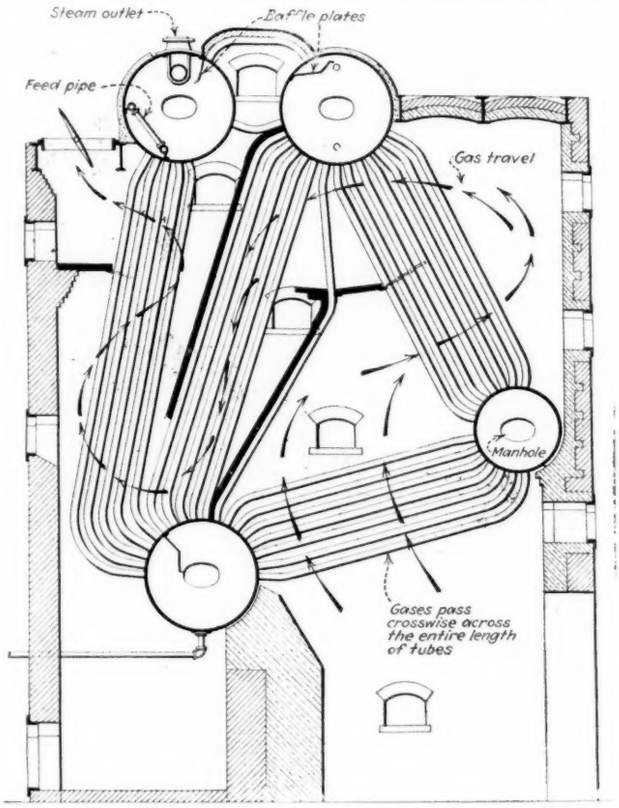


Fig. 2—Bros.-Wetherbee four-drum bent-tube boiler

the grate the coal is discharged to a reciprocating ash plate which carries it forward again a short distance before discharging to the ashpit. There are only three moving parts to the stoker, each of which is supported on rollers. The movement of the grates is adjustable from one to four inches, and the whole mechanism operates from a ¼-hp. motor.

The third new stoker was a hand-feed and hand-operated grate developed by the Slicing Stokers, Inc. It is essentially an assembly of shaking or rocking grates with a stationary bar between each moving grate. A feature of the stoker is the provision made for breaking up the fuel bed by means of a slicing mechanism, which consists of rows of vertical iron pins placed in openings in the stationary bars, the tips of the bars being normally flush with the surface of the grate. The pins are attached in gangs to levers which are operated from the front of the stoker and by means of which the pins are moved straight up into the fire. The levers that operate the slicing device are counterbalanced so that the pins cannot be left up in the fire. The coal is fed to the stoker by means of push boxes in the lower part of the coal hopper.

A model of a water-tube boiler of recent development was shown by the Wm. Bros. Boiler & Manufacturing Co. It is of the four-drum type designed for

ring-flow circulation and with practically complete crosswise travel of gases. The tubes are in horizontal and vertical lines and are spaced on the horizontal alternately wide and narrow to allow the replacement of any tube without removing others. Provision is made for placing a superheater six or seven tubes from the fire or outside the second bank, depending upon the

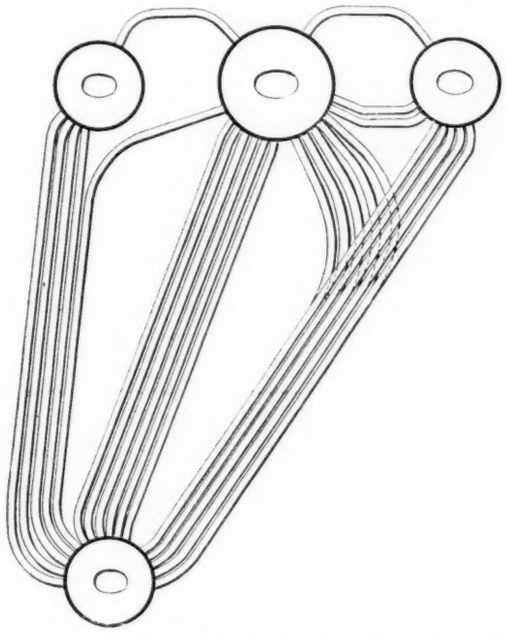


Fig. 3—New type Walsh & Weidner four drum boiler

degree of superheat desired. This company also showed drawings of a three-drum type water-tube boiler designed for small plants with low headroom and to occupy the same height and width as a horizontal return-tubular boiler of the same power. An advantage claimed for this type of boiler is that all parts can be taken

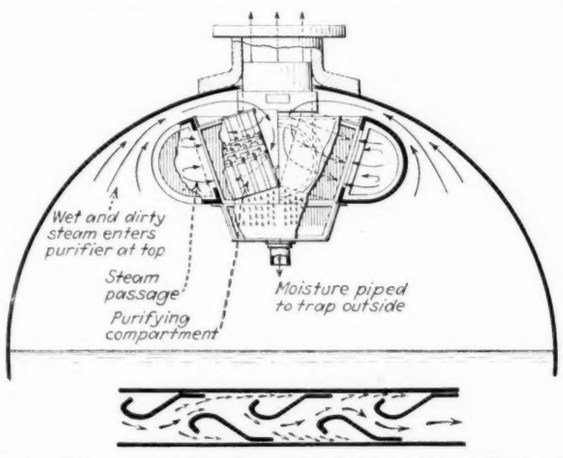


Fig. 4—Steam purifier shown by International Filter Co.

through small openings to sub-basements or to other rather inaccessible locations.

Another recent development in water-tube boilers was shown by the Walsh & Weidner Boiler Co. This boiler is also of the four-drum inclined-tube type, but is a departure from the conventional design in that each alternate row of tubes in the front bank and the front row of the rear bank are connected at the upper end to the center drum, as shown in the illustration, Fig. 3.

The latest practice in boiler construction was shown by the Babcock & Wilcox Co. which company, together with its subsidiaries, the Bailey Meter Co. and the Fuller-Lehigh Co., occupied probably the largest floor space at the show. A section of a 42-in. Stirling drum with machined joints and shrunk-fit drumhead designed for a working pressure of 450 lb. was displayed. Other

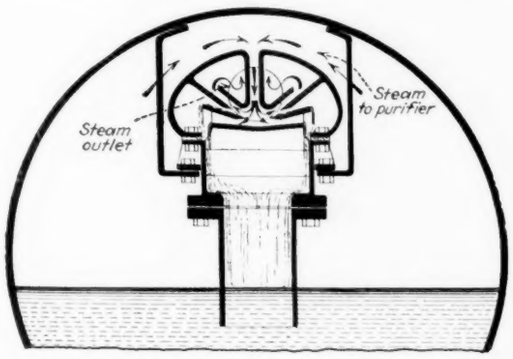


Fig. 5—Schutte & Koerting turbo-steam purifier

boiler parts, such as forged steam nozzles, circulating tube drum connections, superheater boxes and high-pressure plate-glass water columns, were included in the exhibit.

As steam free from moisture and other impurities is now an essential requirement in most plants, several devices for freeing the steam of impurities before leaving the boiler drum were exhibited at the show. Two of the latest purifiers are illustrated herewith. In the

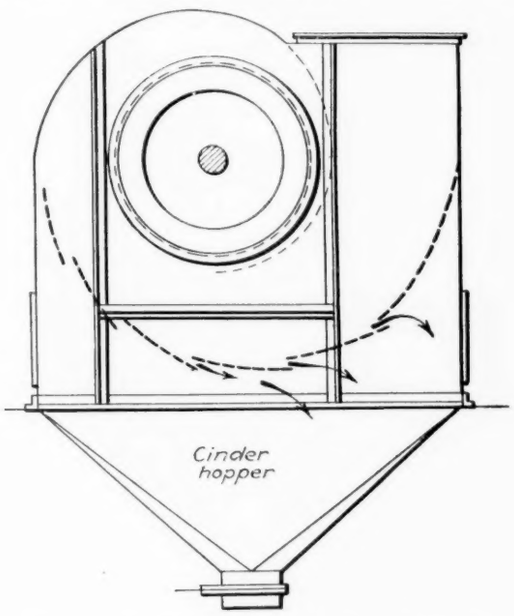


Fig. 6—Cinder eliminating fan shown by Buffalo Forge Co.

purifier Fig. 4, which is made by the International Filter Co., the steam flows through the filter in thin bands or ribbon-like streams which are given an undulating or wavy motion by means of shaped passages between parallel plates or vanes. While the steam readily changes its direction of flow, the heavier particles entrained in the steam are projected into scrubber pockets from which they are finally drained to a point outside the boiler.

A purifier that has been used quite extensively in Europe and for which the American rights have recently been acquired by the Schutte & Koerting Co., is shown in Fig. 5. The drawing is self-explanatory.

A purifier in actual operation separating moisture from air was seen at the booth of the Andrews Bradshaw Co. Here a tracifier was in position in a 42-in.

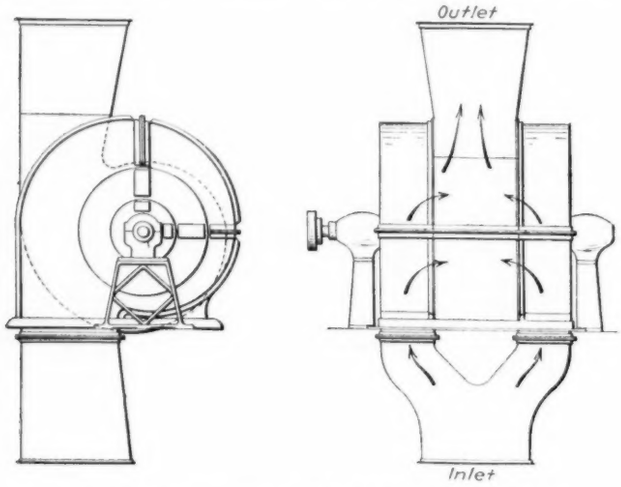


Fig. 7—Sturtevant double-inlet straight flow induced-draft fan

boiler drum which was fitted with a plate-glass head so that the operation could be observed. The drum was half filled with water, and into this air was blown to imitate the action of steam and water entering a boiler drum from the tubes at high rating. The air, after passing through the tracifier, was discharged at the boiler nozzle.

The necessity of eliminating cinders from boiler exit

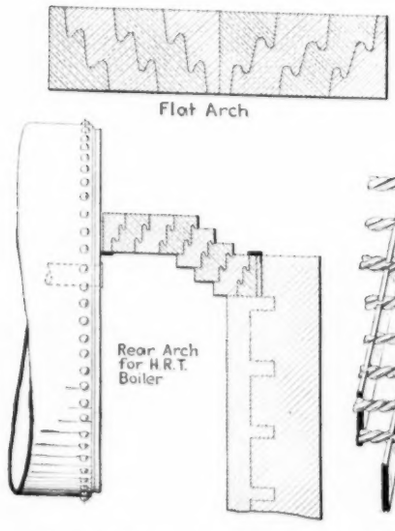


Fig. 8—Reintjes arch tile for flat, single and double stepped and cantilevered arches

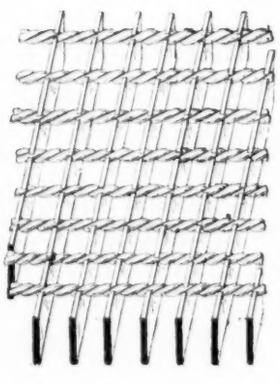


Fig. 9—New type one piece electro-forged grating made by Blaw-Knox Co.

gases is now well recognized, and a new type of fan for this purpose was shown by the Buffalo Forge Co. In this fan (see Fig. 6) the type of rotor regularly used in the duplex and turbo connoidal induced-draft fans made by this company is employed. The cinder eliminating feature is obtained by providing louver openings in the inner scroll through which the cinders and other solids are discharged by the centrifugal action of the wheel and the sweeping action of the air. The chambers into which the cinders are discharged is maintained airtight and is cleaned at intervals as required.

Another induced-draft fan recently introduced into

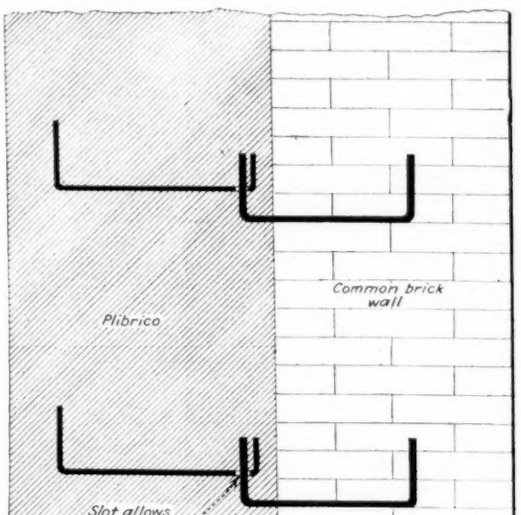


Fig. 10—Plibrico-flexo-anchor provides for expansion and contraction in monolithic furnace walls

the field was shown by the B. F. Sturtevant Co. This fan (see Fig. 7) is designed with special scroll inlets and connections to give a straight flow similar to a

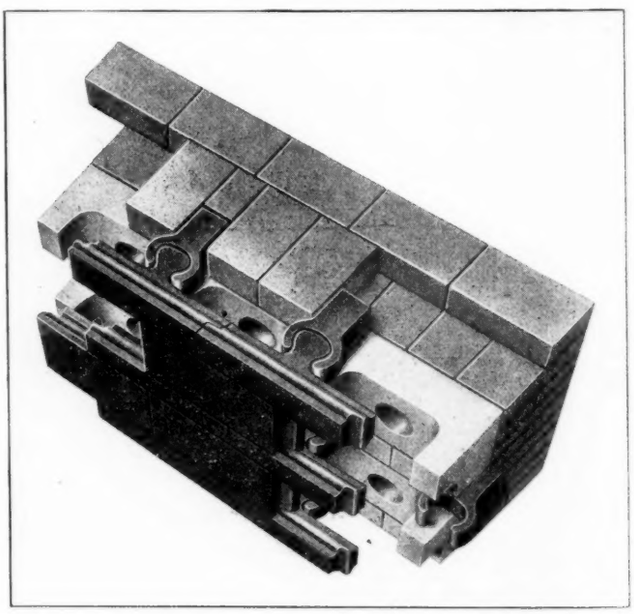


Fig. 11—Improved SX furnace wall construction shown by Drake Non-Clinkering Furnace Block Co.

centrifugal pump. The fan rotor is designed for high tip speeds so that it can be direct connected to an induction motor having a speed of 1,150 or 1,750 r.p.m. To install the fan in existing breechings of flues, it is only necessary to remove a section of the duct and insert

the fan as the inlet and discharge connections are in line. A tubular air heater with lead-coated surfaces was another recent development shown by this company.

New in the line of refractories were the Rentjes arch tile for flat stepped or cantilever arches and flexible corner bonding tile, exhibited by Risher Firebrick Co.

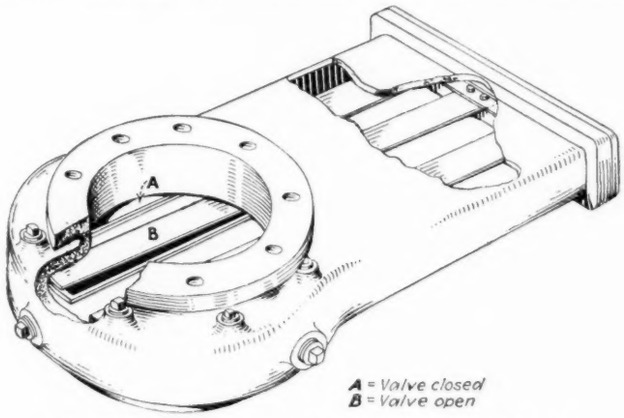


Fig. 12—New type of check valve shown by the G. M. Davis Regulator Co.

With the arch tile (see Fig. 8) only two shapes are used regardless of the thickness of the walls, the varying width of span, or whether used as a flat, stepped or cantilever arch. No structural steel is used for supporting the arch, and it forms its own skewback without cutting bricks. The bonding tile referred to are designed to eliminate the usual faults of corner con-

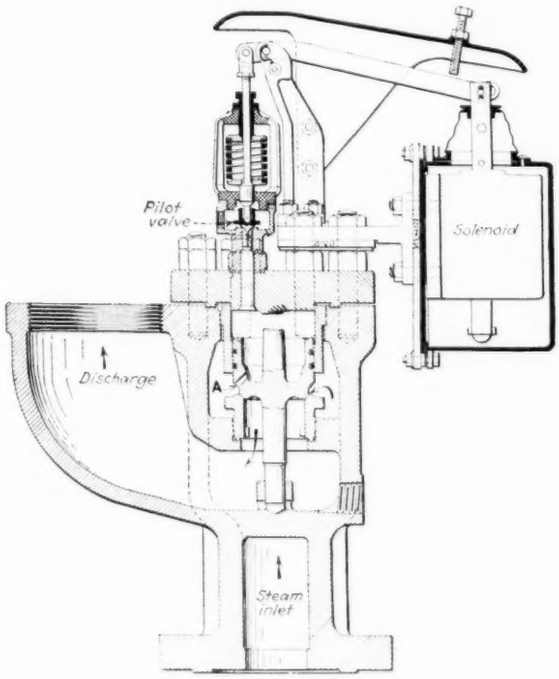


Fig. 13—"Consolidated" electrically operated safety valve exhibited by Manning, Maxwell & Moore

struction and to effect bonding of both side and end walls with ample allowance for expansion. Each tile is the thickness of one course of brick, and when properly set they automatically break the joints of each succeeding course and form the corner of the inner 9-in. refractory lining.

The Plibrico Jointless Firebrick Co. had an actual representation of a furnace wall consisting of a 9-in. common brick wall lined with Plibrico to show the application of the flexo-anchor which the company has recently introduced.

An improved air-cooled furnace wall construction known as the Drake S-X was exhibited by the Drake

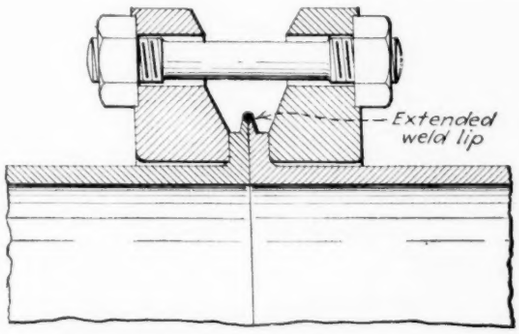


Fig. 14—Extended weld lip on Sargol weld joint introduced by Pittsburgh Piping & Equipment Co.

Non-Clinkering Furnace Block Co., Inc. As will be seen from the view, Fig. 11, the renewable face of the wall is free to move both vertically and horizontally and yet is held firmly in place by anchors secured in the outer wall by header courses. This makes each ten inches of vertical face construction independent of the rest and facilitates the replacement of blocks. Face blocks of silicon-carbide, fused aluminum or fireclay, are available to meet the various installation requirements.

The actual application of "Adamant" cement to furnace walls by means of an air gun was demonstrated in the booth of the Botfield Refractories Co. The gun, which the company has recently brought out for applying this cement, is portable, weighing but a few pounds. It has no moving parts and is operated by a single valve.

A recent development in the line of valves for bleeder and other similar services where a minimum pressure

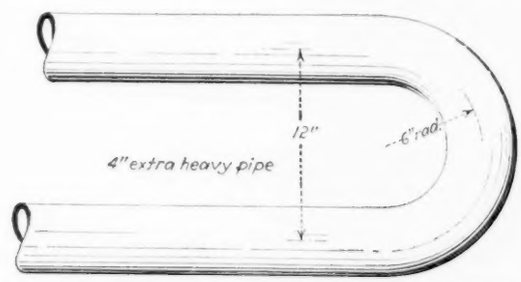


Fig. 15—Unusually short radius return bend of 4-in. extra heavy pipe made by Midwest Piping & Supply Co.

drop through the valve is desired, was a wing-disk valve (see Fig. 12) shown by the G. M. Davis Regulator Co. In this valve the openings through the seat are rectangular in shape and the disks are long strips of sheet brass fastened at one end. A new valve designed especially for close throttling and to eliminate wire-drawing was included in the exhibit of the Walworth Co. In this valve the disk rotates slightly, which action opens or closes a series of small ports in the seat and disk.

A new reducing valve designed especially for low delivery pressure in one stage from high initial pressure was shown by the A. W. Cash Co. The valve is made in sizes from 1 to 10 in.

The showing of manual and motor operated valves for high pressures, by the various manufacturers was extensive and complete. The lines shown included cast steel, dropped forged steel and monel metal bodies with trimmings of monel metal and stainless steel.

As evidence that the safety-valve manufacturers are keeping pace with the demand for high pressures, the

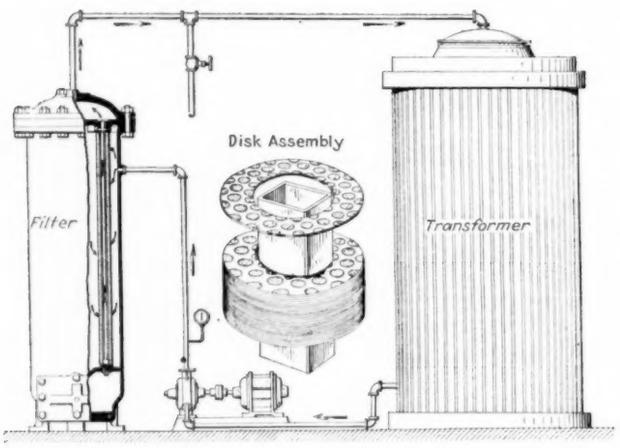


Fig. 16—"Diskelectro" filter for dehydrating and filtering transformer and turbine oil exhibited by S. F. Bowser Co.

Crosby Steam Gage & Valve Co. showed a nozzle-type safety valve for pressures up to 1,500 lb. The design provides full nozzle capacity of the throat tube and for the valve to have full discharge with small accumulation and to close sharply without shock.

The electrically operated safety valve shown in Fig. 13 was a feature of the Manning, Maxwell & Moore exhibit. The purpose of the valve is to reduce the usual 4 per cent blowdown required by spring-loaded valves to a negligible quantity. By referring to the illustration, it will be seen that the valve is of the balanced type and that the steam is discharged through the valve from above the seat. In operation the steam upon entering the chamber surrounding the seat and disk passes through a small port *A* in the disk until the pressure above and below are equalized. As the area on the top side of the disk subjected to pressure is much greater than the area below the disk, the valve is held shut. When the upper limit of pressure on the boiler is reached the solenoid is energized through a special Bourdon gage spring control and opens the pilot valve, which in turn releases the pressure above the main valve, allowing it to open. When the current to the solenoid is again broken through a slight drop in pressure, the pilot valve is closed by the action of a spring mounted on the valve spindle, the pressure builds up above the main valve and it closes without shock.

To facilitate the process of welding the sargol joint on high-pressure steam lines, the Pittsburgh Piping & Equipment Co. showed a joint on which the welding lip was extended (see Fig. 14) about $\frac{3}{8}$ in. This improvement also lessens the amount of heat conducted into the flanges.

The new pipe joint known as the Kell-Raph, developed by the M. W. Kellogg Co., was shown at the booth of the D. H. Skeen Co. This joint consists of a copper-plated steel gasket inserted between grooved flanges. The latter company also showed the improved type E Stets boiler-feed controller and the latest method of connecting the Mercon water level and excess-pressure regulator, in which the excess-pressure regulator is placed between the water level regulator and the boiler instead of on the opposite side, as formerly.

As an example of what it is now possible to do in the art of pipe bending, the Midwest Piping & Supply Co. showed a return bend made from 4-in. extra-heavy pipe and bent on a 6-in. radius (see Fig. 15). Heretofore, a radius of four times the pipe diameter has been considered the minimum.

A new type of filter known as the "Diskelectro," designed especially for dehydrating and filtering transformer and switch oil, was shown by the S. F. Bowser Co. In this filter a number of spindles consisting of thousands of metal disks mounted on a hollow square rod are suspended in a vertical cylinder (see Fig. 16). Oil is pumped into the chamber surrounding the spindles and is forced through the spaces between the disks. The oil, after passing between the disks, flows to the bottom of the spindle and rises up through the hollow square bar and thence back to the transformer. The disks are separated by means of electroplated spacer spots formed on one side of each disk. These spots separate the disks 0.00042 in. In filtering, the low surface tension of the oil permits its passage between the disks, while water globules, sludge and other impurities are held back. To clean the outer surface of the spindles, clean oil is forced through the disk spindles in the opposite direction. A special type of pump is used with the filter, the one shown in the illustration being only diagrammatic.

In addition to its regular line of oil-purifying equipment the Sharpless Specialty Co. showed a small device known as "Samplitt" for discharging samples of oil from the oil line at certain intervals depending upon the pressure and rate of flow in the oil line.

Probably one of the most spectacular exhibits in the

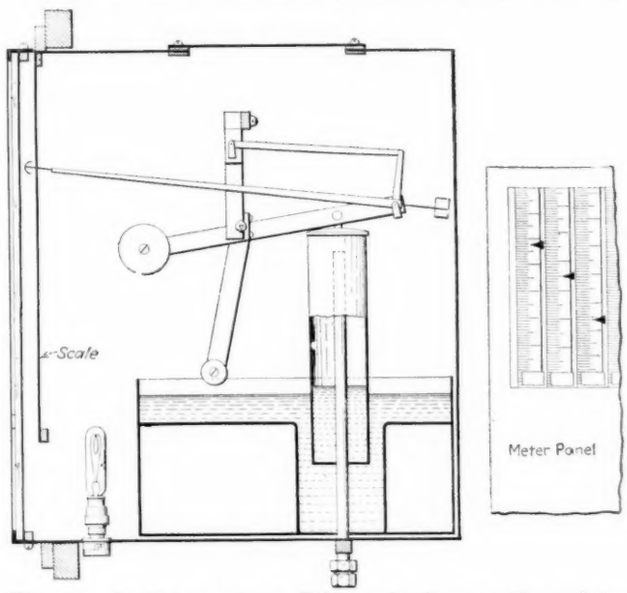


Fig. 17—In the new type Ellison draft gage the pointer moves in a vertical straight line

line of instruments was that of the Brown Instrument Co. A large model of an electrical flowmeter brought out recently by this company was shown in operation. The pointers and inductance coils, which were of large proportions, were mounted on plate glass so that the self-adjusting inductance-bridge principle of the meter could be readily observed. Sections of the manometer

and indicating and recording instruments used with the meter were also shown. Other instruments recently developed by this company in which the same manometer and inductance-bridge principle are employed, are water level gage for steam boiler, liquid level recorder measurement of gas under low pressure and measurement of water flowing over a weir. A detailed description with illustrations of this steam-flow meter were given in the Sept. 28, 1926, issue.

A recent development in the line of draft gages in which the scale (approximately 10 in. in length) is vertical (see Fig. 17) and not curved as is the usual practice, was exhibited by Lewis M. Ellison. In this instrument, which is of unusually substantial construction, the complete movement is suspended on knife-edges and is so designed and counterbalanced that the pointer moves in a vertical straight line and the graduations are equal at all points of the scale. The gages are arranged for flush mounting and for grouping on a panel, as indicated at the right of the illustration.

The most extensive showing of boiler and turbine room instruments was that of the Republic Flow Meters Co., which featured especially a boiler-meter panel board and turbine-meter panel board designed for unified operation or control of these units.

A new trap known as the "Cataract," designed especially for use with low pressures and to have a large capacity, was featured by the Boylston Steam Specialty Co. Traps of comparatively recent development were

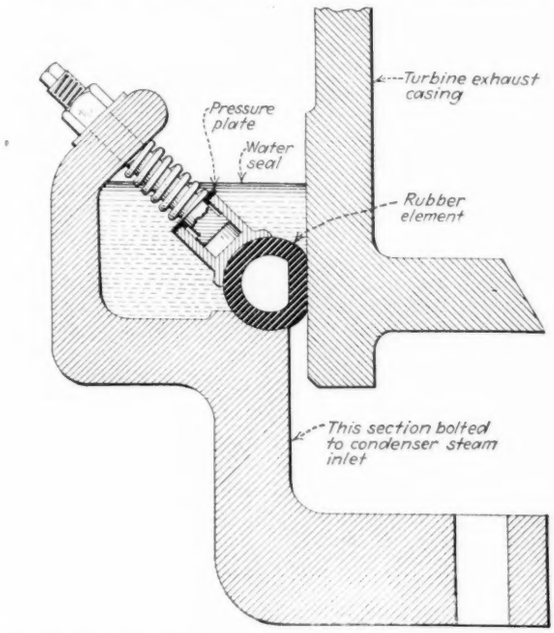


Fig. 18—A thirty-five foot section of Phillips expansion joint built for a 30,000-kw. turbine was exhibited by the Henry Pratt Co.

also shown by the Armstrong Machine Works and the Wright-Austin Co. The latter company also featured its new "Clearview" gage-glass protector, consisting of a semicircle of thick wire glass on the front of the gage glass and a heavy woven-wire guard between the glass and the column.

An improved expansion stack connection designed to provide an airtight connection between the breeching and stack and still permit expansion and contraction without bulging, was shown by Connery & Co.

The Westinghouse Electric & Manufacturing Co. showed its latest design of turbine-driven exciter unit. The turbine has single impulse wheel running at 7,200 r.p.m. and connected with the generator through a double herring-bone gear which is inclosed within the same casing as the turbine. The impulse wheel is mounted on the end of the reducing gear pinion shaft, no outboard bearing being used. The unit is equipped with oil-pressure governor, the oil being supplied by a pumping element on the high-speed turbine shaft.

The Allis-Chalmers Co., in addition to showing an inclosed self-ventilated motor and a complete unit of

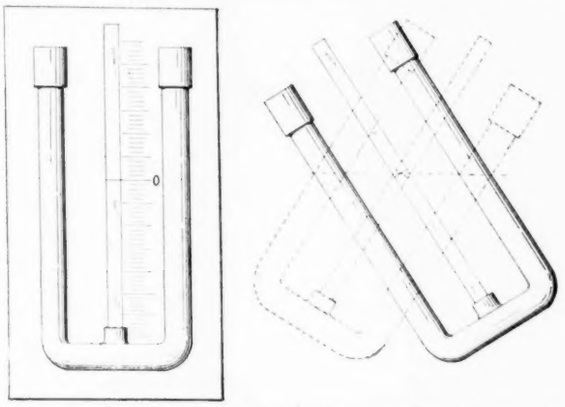


Fig. 19—Ellison draft gage with two liquid chambers which serve to maintain a constant zero reading in any out of vertical position

Reyrolle switch gear, had a ½-in. scale model of a 50,000-kw. steam-turbine generating unit and condenser now under construction for the Waukegan Station of the Public Service Co. of Northern Illinois.

The latest in multistage feed pumps designed for pressures up to 900 lb. and equipped with hydraulic balancing devices to neutralize the end were shown by the Ingersoll-Rand Co. and the Worthington Pump & Machinery Corp.

Included in the extensive showing of electric equipment by the American Brown Boveri Co. and its subsidiaries, were voltage regulators, transformers, circuit breakers and a mercury arc-power rectifier having a direct-current output of 1,000 amp. at 1,500 volts.

A rado-jet air pump with after condenser arranged with two compartments for bad water conditions was included in the exhibit of the C. H. Wheeler Manufacturing Co. The employment of two independent compartments in the condenser makes it possible to clean the tubes without taking the pump out of service.

One of the most attractive exhibits at the Show was that of the Nash Engineering Co., which included synchronous motor-driven centrifugal air compressors and vacuum pumps, vacuum return-line heating pumps complete with receiver and automatic controls, and small centrifugal pumps. The attractiveness of this exhibit was much enhanced by the addition of mirror panels in the imitation concrete wall on two sides of the booth and by a raised floor with grating inlaid at various points.

A new line of subway grating "Security" (see Fig. 9) now being introduced by the Blaw-Knox Co., was another new development seen at the Show. The grating is manufactured by laying the twisted bars across the top of the bearing bars, without slotting or cutting the metal. By the application of several tons pressure and resistance welding the bars are forged into one piece where they cross.

Finding the Performance of an Ammonia Refrigerating Plant

By A. T. NICHOLAS
Instructor in Mechanical Engineering, the Pennsylvania State College

IT IS impossible to compare the results obtained in two refrigerating plants by a check of the tons of refrigerating output per unit of power. The difficulty lies in the lack of similarity of operating pressures, temperatures, etc., in the plants being subjected to the study.

However, the use of the temperature-entropy graph of the ammonia cycle permits a simple method of determining the performance of the unit if the conditions of operation are known. It is sometimes difficult to represent the cycle on this basis, owing to the practical conditions of the system under which it works. This is especially true of the flooded system where the liquid is precooled prior to its use in the expansion coils. To illustrate, the writer has taken test data as reported in *Power* some time ago, in which the coils operate on the flooded system. Fig. 1 shows a diagrammatic arrangement drawn up from the description and the test data, representing the conditions of ammonia during the test as to pressure in pounds per square inch absolute and temperature in degrees F., Fig. 2, represents, the temperature-entropy graph of the cycle. The heat-content data shown were taken from Bureau of Standards tables, although any of the several existing tables give the same approximate results, as obtain in the figure.

Charting the Events

The study and description of the cycle may now be made from Fig. 2. Dry saturated vapor is drawn into the compressor at C and is compressed to D. Owing to line drop of pressure and temperature, the condition of the vapor prior to entering the condenser falls slightly, as shown by P_1 and P_2. The superheat is removed by the condenser from D to E and the latent heat from E to A. What happens between A and B may now best be seen with the aid of Fig. 1. First the liquid expands through the expansion valve, then mixes with the returns from the expansion coils, this mixture then flowing into the cooler.

The liquid when in the cooler is precooled to a lower temperature than the corresponding pressure by the rapid boiling of part of the fresh liquid from the expansion valve. Approximately, 17 per cent of the liquid is thus evaporated and passes off to the suction of the compressor; the remaining 83 per cent is precooled to the temperature of the liquid in the cooler and is used in the expansion coils. This state is represented from point A to point B, Fig. 2. From B to C the vapor is dry and saturated, being of 100 per cent quality. It is interesting to note that the heat abstracted from the brine takes place at 1.62 deg. F. lower than the corresponding pressure.

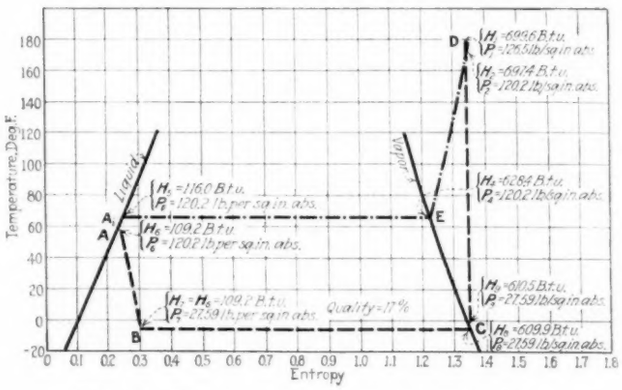


Fig. 2—The cycle shown on a temperature entropy chart

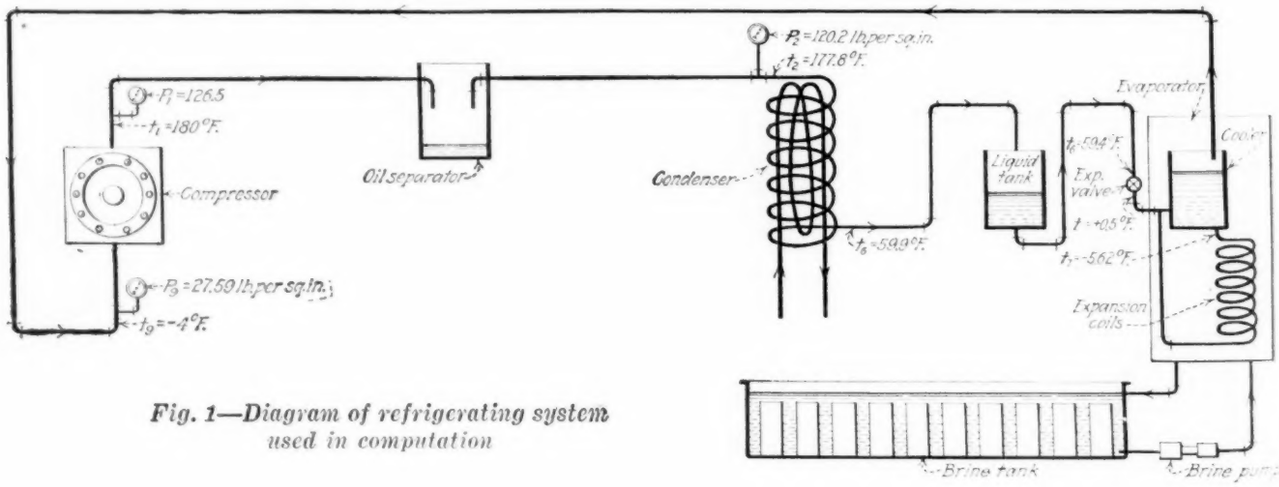


Fig. 1—Diagram of refrigerating system used in computation

The actual coefficient of performance may now readily be found. By definition it is:

$$\frac{\textit{Heat removed}}{\textit{Work done}} \text{ or } \frac{\textit{Heat content at } C - \textit{Heat content at } A}{\textit{Heat content at } D - \textit{Heat content at } C} = \frac{609.9 - 109.2}{699.6 - 610.5} = 5.62.$$

This coefficient can never exceed the ideal of Carnot cycle coefficient between the same suction temperature, —4 deg. F., and condenser temperature of 59.9 deg. F. For these temperature limits the Carnot cycle coefficient will be $\frac{t_s}{t_d - t_s}$, or $\frac{(460 - 4)}{59.9 - (-4)} = 7.13$. The relative efficiency of the actual plant will be $\frac{5.62}{7.13} = 0.788$, or 78.8 per cent.

The ideal, or Carnot cycle, coefficient of performance varies slightly with lower temperatures and the same

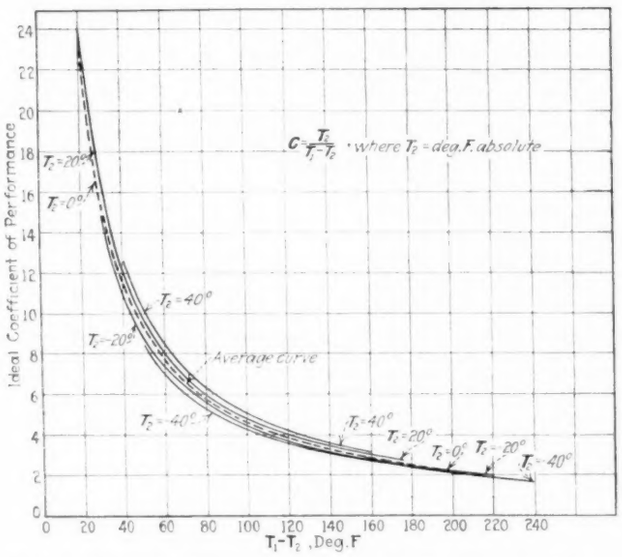


Fig. 3—Ideal performance curves for various suction and discharge conditions

temperature difference. Fig. 3 shows the manner of variation. It is so slight that for all practical purposes an average curve might be drawn to represent all the lower temperatures. From this average curve, for the foregoing temperature difference, the Carnot coefficient is found to be 7.10 as against the calculated 7.13. A curve of Fig. 3 type permits of an easy determination of the ideal efficiency, from which the relative efficiency may be found, as above.

THE EFFECT OF THE SUCTION AIR CHAMBER on a pump is to take away from the suction chamber of the pump, the water hammer and disturbances resulting from continuous flow into the pump suction chamber from which the discharge is intermittent. The ordinary air chamber in the discharge side of the pump changes the intermittent flow into a continuous one, whereas the suction air chamber has for its object the conversion of a continuous flow into an intermittent one. Just as in the discharge-pipe air chamber, air in the suction-pipe air chamber acts like an elastic cushion which noiselessly receives the excess of flow and gives it out again. The air is thus alternately expanded and compressed at each wave or impulse of water flowing into the pump chamber.

Setting the Fuel Value of an Air-Injection Diesel

BY A. B. NEWELL

THE time of fuel-valve opening on a Diesel engine is without doubt the most important feature of valve timing. However, we find a number of methods employed in making this adjustment, and since these methods are not fundamentally the same, some of them must be incorrect.

The engine indicator, when employed, tells whether or not the fuel valve has been correctly timed. But since there are many engines in operation which seldom if ever have an indicator diagram taken from them, it is necessary to employ a method of fuel-valve setting which comes the nearest to giving the same results when applied to a number of different cylinders on the same engine and on a number of different engines. Such a method will make it possible to re-establish the original setting of the fuel valve in accordance with the instructions of the engine builder.

The engine will have, or should have, a series of marks on the flywheel or a crankshaft coupling with the valve setting established and stenciled, so that there can be no mistake as to what point the valves should open and close. On all valves, save the fuel valve, a variation of the cam-roller clearance will be the only adjustment to make, and the engineer will use his own judgment, based on the instructions of the engine builder and probably influenced by experience and the amount of noise the rollers make, as to how much clearance he will give. No harm will result in a slight variation unless such variation of adjustment holds the valve open at all times or makes the clearance so great as to cause the valve to close with a crash.

With the fuel valve it is a different matter. A considerable variation of clearance will change the time of opening and closing, shortening or lengthening the duration of injection to such an extent as to affect seriously the condition of combustion which in turn can bring about good or bad operating conditions, as the case may be, and will therefore bear careful watching. In most instances if the time of fuel valve opening is correct and the duration of injection is as great or greater than is called for by the engine builder, nothing more will be required so far as timing is concerned.

If the crank is set for the correct angle for the point of fuel-valve opening and the clearance is merely reduced until the roller is in contact with the fuel valve cam, there is no assurance that the valve is starting to open or that it will start to open within the next one or two degrees, for there is a heavy tension on the fuel valve needle which is held shut with a spring, and before the cam has applied sufficient pressure to the roller to lift the valve, the rocker arm will spring slightly, the film of oil will reduce somewhat in the bearing of the rocker and roller and all other parts involved will become rigid and hard set in place in preparation for the actual effort required to lift the needle against the weight of the spring. It is not possible to judge by feeling of the roller as it comes in contact with the cam, just what pressure is being applied, and for this reason a contact setting is not accurate.

A more accurate method is to take hold of the fuel valve needle with a wrench and apply a slight effort as if to turn it, and then reduce the roller clearance until the needle is no longer gripped in its seat and turns

freely. Care should be used, if this method is employed, to have the needle barely start to lift. This can be checked up by turning the engine back and then bringing it ahead again while feeling of the valve. The instant the crank comes to the correct angle, as indicated by the markings on the flywheel, the needle should be felt to free itself from the seat.

The most accurate method is what is known as "setting with air." By this method the crank is first set at the correct angle. Then an air inlet valve is blocked open, commonly by slipping a thin block of wood between the roller and cam to hold them apart. It will then be possible to hear what is going on within the

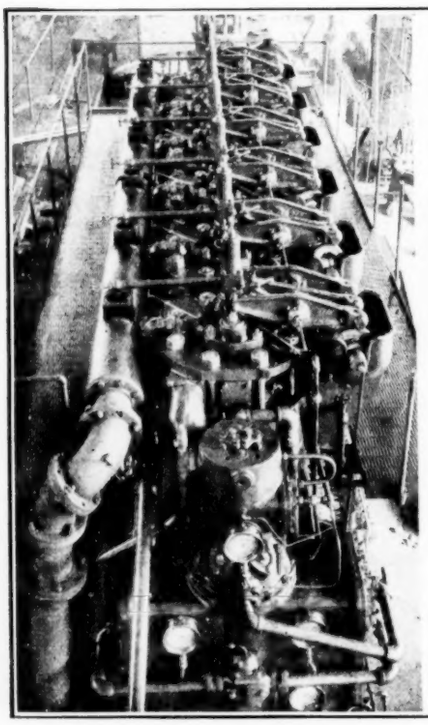


Fig. 1—Valve gear of six-cylinder Diesel

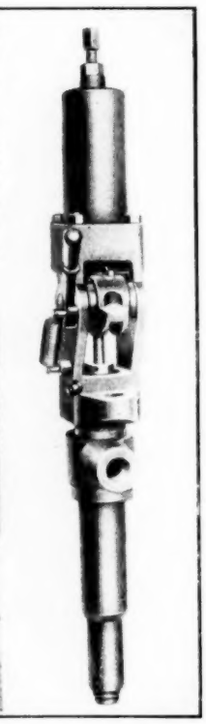


Fig. 2—Typical fuel valve

cylinder by listening at the air-inlet breather pipe. On two-stroke-cycle engines the relief valve or indicator cock should be used. With this preparation made, turn on the injection air, not necessarily full pressure, for any pressure will do. While one man is listening at the open valve, another can reduce the roller clearance until the air can be heard to blow, very faintly, into the cylinder. By manipulating the adjusting screw, the air can be made to start to blow at the right moment. Once the adjustment is made in this way, it is a good plan to turn the engine backward and then ahead again slowly, watching the mark on the flywheel and listening at the open valve. Air should be heard to start blowing by the fuel valve the instant the mark indicates that the time of opening has been reached.

The object of turning the engine in this way is to bring about a condition similar to the running condition, for it is known that a certain amount of slack motion exists in all timing gears and unless the last movement of the crank has been in the ahead direction of rotation the slack may be on the wrong side of the gears. It would not do to reverse this process and turn the engine backward, assuming that if the air stops blowing at the correct moment, it would start blowing at the same moment if the engine were turned ahead. The slack in the gears would first have to be taken up to start the valve to open.

On some engines it is necessary to readjust the fuel valves quite often, and time is not always available to make the adjustment with air. On such as these it is a good plan to set first with air and then take the roller clearance of each individual fuel valve. Thereafter the valve may be set to roller clearance several times and occasionally checked with the air process.

It is also best to do this work while the engine is warm, and always attempt to have it about the same temperature when setting the fuel valve roller clearance, since on some engines a general change in temperature tends to change the fuel valve setting slightly. It is best to choose a time, say half an hour, after closing down, or before the engine has had time to cool.

Starting Oil Fired Boilers

The American Marine Standards Committee has made certain recommendations as to the operation of oil burners, which apply equally to stationary plants.

When an oil-fired boiler has been made ready as and before proceeding to light off, take all due precautions to free the furnaces of explosive gases.

Dampers in uptakes of smoke pipes are not generally installed for oil-burning boilers, but if provided, they must be pulled wide open before lighting fires, and they must never be closed more than 66 per cent except when the air-control registers are under repair, thereby opening the boiler front.

Wipe up all oil on floor plates and elsewhere.

Blow out furnaces with air or steam or, if neither is available, thoroughly ventilate the furnaces by opening the air registers.

Inspect for and effectively stop all oil leaks.

Open the proper valves in the oil-pump suction line.

If steam is available, start the oil service pumps and put pressure on the oil-service line to the burners.

In lighting up, 75 to 150 lb. pressure on the oil line is sufficient, depending upon the type of burner, that is, whether high or low pressure.

While circulating oil before lighting off, bypass the oil meter until ready to light up. Otherwise it will operate while air is being pumped out of the line in which oil is being circulated. As soon as fires are lighted, cut in the meter again.

Have the blowers warmed up and ready to run.

Drain or pump into the sump tank, or through the separator if one is installed, any water that has accumulated in the oil settling tank or tanks.

Cut in the fuel-oil heater if steam is on the line, and circulate around the system to insure that the lines to the burner are clear.

Open and light off the center burner, which should have a small tip, using a hand torch placed near and just under burner. Stand well clear to avoid a flareback.

After steam is generated and the furnace is hot, if the draft is sufficient, the burners adjacent to the center one on both sides may be lighted. A hand torch should be used to light the burners until the brickwork becomes intensely hot, and even then if all burners are out. No matter how hot the furnace may be, if all burners are temporarily out, do not attempt to relight from the incandescent brickwork.

Extinguishing Fires in Electric Generators

PROTECTION for electrical equipment against internal and external faults has been highly developed, but protection against fires is still in an embryo state. If a failure occurs in the winding of a generator, it can be automatically disconnected from the line and made dead before any extensive damage is done. But if a fire happens to start in the winding, there is no telling how extensive the damage may be. Where water or steam is used to extinguish the flames, the cure may be worse than the disease. In any event the windings must be thoroughly dried out before the machine can again go into service, although the effects of the fault may be small and quickly repaired. Attempts have been made to confine the water to the section of the windings where the fault occurs, but it requires about as much time to dry out part of the winding as the whole.

What is needed is some method that will extinguish the fire as quickly as it develops or prevent it from starting. The answer to the latter is to operate the machine in a gas that will not support combustion. Although this has been tried and is still being experimented with, difficulties present themselves that have left serious doubts in the minds of plant operators. Many of them are of the opinion that they would sooner gamble with the possibility of having to flood the winding with water or steam than always to have present the attending dangers when the generators are filled with a gas that will not support combustion.

The suggestion made in an article in this issue to use carbon-dioxide gas to extinguish fires in electrical equipment has much to commend it. This gas, applied in different ways, has been used for this purpose for some time, but like the other methods, leaves much to be desired. It is, however, superior to water or steam, as it does not temporarily destroy the insulating qualities of the windings, can be easily removed and leaves the machine ready for service as soon as the fire damage is repaired.

CO_2 and Flue-Gas Temperature

ENGINEERS in charge of the operation of steam boilers are familiar with the fact that the flue-gas temperature drops with an increase in the percentage of CO_2. Increased CO_2 is an indicator of higher furnace temperatures and reduced excess air. These facts have been demonstrated by temperature measurements on boiler tests and by practical experiences with boiler walls, which frequently show signs of failure with increased CO_2. In fact, the limiting capacities of many furnaces is the temperature that the side walls will stand. Operators maintain combustion conditions so as not to exceed a certain percentage of CO_2 which corresponds to the highest safe furnace temperature.

Although this decrease of flue-gas temperature with increase of CO_2 is such a well-known phenomenon to engineers, one often finds it difficult to explain why this takes place, if asked for a definite reason by a beginner in power-plant operation. Many explanations have been printed from time to time, each of which attempts to explain the facts in a rational way, and in general the underlying theories are correct. Another explanation was recently offered which may be new to many engineers and which may help clear up certain misunderstandings on this point.

As already stated, increased CO_2 indicates higher furnace temperature. It is generally said, if there is much exposed heating surface, that an increased heat transfer by radiant heat will occur to this exposed surface and to the tubes of the first pass of the boiler. The decreased temperature in consequence of such absorption tends to lower flue-gas temperatures.

Increasing knowledge of the characteristics of gases indicates that there may be another factor involved. It is now known that CO_2 and water vapor have radiating properties of their own. It will therefore be apparent that a portion of the heat given up by the gases passing over boiler surfaces is radiant heat emitted from these hot gases. An increased percentage of CO_2 is accompanied by an increased percentage of water vapor. As a consequence, with increased CO_2 and water vapor there will be an increased mass effect of these gases as radiant heat dissipators while passing through the boilers. As the total mass of gas is reduced owing to diminished excess air, the net result will be a lower final flue-gas temperature although the furnace temperature has increased.

The Cost of Not Knowing

KNOWING the efficiency of a unit in a power plant at a certain time is not an assurance that this efficiency will be maintained. Testing waterwheels in place and working up loading schedules is a highly desirable practice, but unless means are provided to obtain a check on the unit's daily operation, a large part of the benefits of the tests may be lost. Under certain conditions the seal rings may wear quickly and a large waste of water may exist for a long time without being detected, unless another test is made or the seal clearance checked.

Where the racks are raised during ice periods, there is danger of pieces of timber or other material lodging against the turbine gates. These may take positions where they do not interfere with the mechanical operation of the unit, but seriously affect its efficiency. With the wide rack-bar spacing used on some machines, there are possibilities of materials reaching the turbine gates and seriously interfering with the flow. Even when heavy objects do not get through the racks to interfere with the operation of the turbine, the building up of

this material at the bottom sections of the racks may result in a considerable loss of head.

The most desirable arrangement is to have a continuous record of the water flow. In plants where methods of obtaining intelligent records of operation have been adopted, the saving has been such as to make them highly economical. No standard method has yet been suggested for obtaining records of water flow. One of the simplest ways is to use the turbine as a water meter, by calibrating the gate-opening positions when the turbine is being tested. The position of the gates will be affected by the wear in the operating mechanism, and this method has other objections as a means of measuring flow.

In some cases Venturi tubes have been installed in a section of the penstock. So far as measuring the flow is concerned, this is an ideal method, as the indicated, recorded and integrated values can be obtained on suitable meters. This provides a means of checking flow against kilowatt output, on total water volume for a given period against the kilowatt-hours. This method is applicable chiefly to high-head plants and has the objection of cost of the tube and the loss of head. However, it is being used successfully in a number of installations.

To eliminate the objections to the Venturi tube in the penstock, effort is being made to use the pressure differential across a length of penstock, where there is a reduction in section, or by taking the differential across the penstock valve, to operate the meters. This is accomplished with varying degrees of success and deserves careful consideration. Until some method of obtaining a continuous check on turbine operation has been found, the full benefit of accurately testing these units will not be realized. There has been considerable discussion on the cost of testing and providing means of obtaining records of water flow to hydraulic turbines. Another cost too frequently overlooked is that of not knowing what the units are doing. This is the most dangerous, since it is not directly in evidence on the balance sheets.

Workmanship

SOME decry modern workmanship and sigh for the "good old days when mechanics were mechanics." There is just enough truth in this view to mislead many. The all-round mechanic, competent to build a complete machine with no other guide than a blueprint, is far less common that formerly, although his species is by no means extinct. On the other hand, more high-grade mechanical work is being turned out today than ever before in the world's history. Compare the buggy with the latest automobile, for example.

Modern production methods are the obvious cause of these seemingly contradictory conditions. The keystone of American prosperity is mass production, without which endless toil can do little more than supply the bare necessities of life. Specialization is an essential element in mass production. It was inevitable that the old-time machinist should, in large measure, be replaced by the machine operator. Properly instructed and continually checked by inspectors who gage each piece produced, this man turns out work fully as good as the best product of the old-time all-around machinist working with the tools and machines of his day. Often the job is notably better; invariably it is done far more quickly.

There is, then, no cause for worry about workmanship, which is now on a higher plane than ever before in the world's history. The case of the workman himself is less clear. Many claim, with some show of proof, that modern industrial organization has destroyed the old-time craftsmanship—work done with intelligence, skill and pride. This is only partly true. The industrial organization is not a machine that can run itself. It requires constant care and oversight. Moreover, it creates a great body of auxiliary needs. Opportunity to exercise skill of brain and of hand is furnished in the design and construction of the necessary special tools and machines. Erection, repairs and millwrighting are jobs still open to men with the craftsman instinct. Operation of delicate and expensive machinery, such as that found in the modern power plant, is no task for the dullard. Finally, research is developing on a large scale, offering to thousands of men a unique opportunity for self-expression in what is perhaps the most interesting and productive of all occupations.

No, the spirit of workmanship is not dead. Industry is so organized that there is plenty of room for men with skill and the determination to use it. Less ambitious workers are able to earn a good living by engaging in specialized production for a reasonable number of hours, and have ample time left to indulge their mechanical or artistic bents in avocations that range all the way from radio to tinkering with the family automobile.

The Power Prize

YEAR in and year out *Power* brings to its readers a wealth of information concerning the improvement of the power plant. What have you done with it? Here is a chance to tell other readers, with an opportunity for securing appropriate recognition if your accomplishments are top notch.

Briefly, the prizes of $500, $250, and $100 are to be awarded for the articles showing the most commendable improvements in the results obtained from the modernization, reorganization or improved operation of a power plant during the last two years.

May 15, 1927, is the dead line for receipt of these articles by *Power*. They have already begun to come in. Start yours now.

BOILER HORSEPOWER, the engineer's old friend, still hangs on, although it outlived its usefulness thirty years ago. What is the reason? It probably simmers down to this: Most present-day engineers did a lot of sweating to find out just what was meant by the mysterious term. They finally discovered that it meant two entirely different things, "area" on the one hand and "rate of heat output" on the other. They also discovered, if they thought much about it, that there were perfectly good ways of expressing both of these quantities long before the hocus pocus of boiler horsepower was thought of. But it hurts to junk such knowledge.

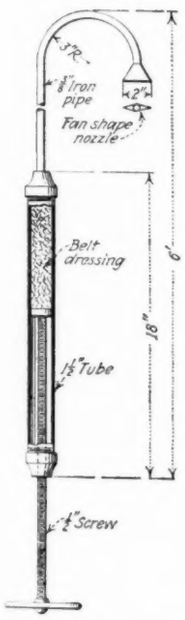
"THERE ARE MANY who find it much easier to calculate than to think. Give them a formula and they are happy. The labor in applying it may be great, but the results are perfectly definite. On the other hand, a judgment formed on the basis of observation and experience may be perfectly sound, but it is necessarily more or less personal to the individual, and is possibly formulated vaguely and in general terms." This quotation from *Engineering*, of London, prompts the query, "What about the vast numbers who abhor thinking and are incapable of applying formulas?"

Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Gun for Applying Belt Dressing

One of the most dangerous jobs the engineer encounters is the care of belts in factories using overhead countershafts. In applying belt dressing, the usual practice is to mount a ladder with a bucket of dressing and a brush. That more men do not get caught by moving belts is remarkable.



Design of belt dressing gun

To avoid this dangerous practice, the gun shown in the illustration has been devised. It consists of a piece of 1½-in. tubing threaded at both ends to receive two caps. One of these is lapped and threaded for a ½-in. screw bolt, while the other is threaded to receive a ⅜-in. pipe. The details are shown in the illustration.

The nozzle should be fan-shaped with a very narrow opening to spread stream out like a brush. Or if desired, a narrow stiff brush could be fastened to one side of the nozzle to insure even distribution of the dressing on the belt.

This is a very handy device, as it saves time and the trouble of getting a ladder and climbing up among belts, pulleys and shafting to apply dressing with a brush.

H. C. LINCOLN.
North Warren, Pa.

"Being on the Job"

I was recently a witness to a case of devotion to duty on the part of a young paper-mill master mechanic that was such a perfect example of "being on the job" I think it worthy of attention on the part of brother engineers.

My wife and I were spending a quiet Saturday evening with this young master mechanic's family, playing Penny Ante, when a severe thunder and lightning storm came up. Taking time out for a moment, this "go-getter" laid out his rain coat, boots, flash light and keys on a chair in the kitchen, threw off and on the electric lights in the house and came in calling for the dealer to deal him a hand.

Having my curiosity aroused, I asked him what all the preparations were for, and he explained that he had thrown his own lighting circuit over from the public service to the paper-mills power. If the lights went out, he would know the lightning storm had caused trouble at the mill, either by circuit breakers going out or by the operators at the paper mill flashing a signal. He could then grab his "trouble shooter" necessities and be on the job with the minimum of lost time.

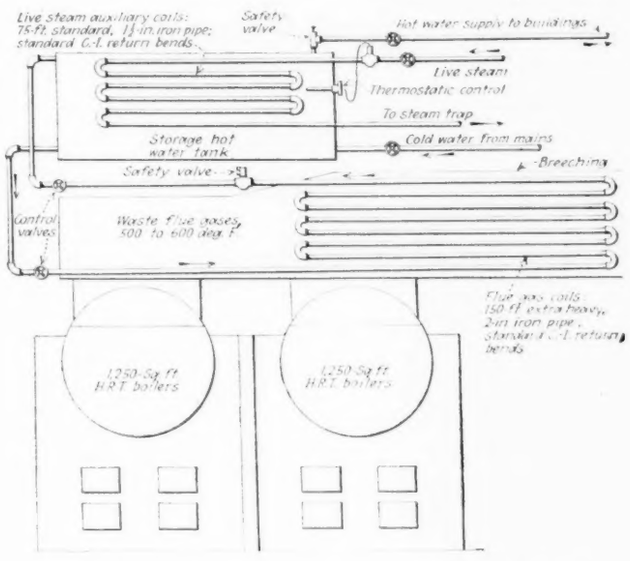
It is needless to say that the production of this plant is good.

FREDERICK C. SCHUELER,
Chief Engineer Union Stock Yards & Transit Co.
Chicago, Ill.

Flue Gases Heat Service Water

The accompanying sketch illustrates a method I have used for heating the hot-water supply for the Elon College dormitories. In the college power house two 1,250-sq.ft. return-tubular boilers are provided with a common breeching to the stack. The water, coming from the bottom of the hot-water storage tank, passes up through a coil in this breeching, is heated and returned to the tank.

An auxiliary live-steam heating coil is also provided in the storage tank, which is thermostatically controlled, so that large demands for hot water can be cared for.


Live steam auxiliary coils: 75-ft. standard, 1¼-in. iron pipe; standard C.I. return bends
Safety valve
Hot water supply to buildings
Live steam
Thermostatic control
To steam trap
Storage hot water tank
Cold water from mains
Breeching
Safety valve
Control valves
Waste flue gases, 500 to 600 deg. F.
Flue gas coils: 150 ft. extra heavy, 2-in. iron pipe; standard C.I. return bends
1250-Sq. ft. H.R.T. boilers
1250-Sq. ft. H.R.T. boilers

Layout of system, showing "home-made" flue gas water heater

In practice it is found that heating by live steam is rarely required.

As indicated on the sketch, the flue-gas heater contains 150 lin.ft. of extra-heavy, 2-in. iron pipe, made up in a coil with cast-iron return bends.

Although apparatus is not at hand for making a precise scientific test, it has been possible to make a rough estimate of the saving. It is estimated that about 2,000 gal. of water per day is heated from 60 deg. to 180 deg. With 13,000-B.t.u. coal, an over-all boiler efficiency of about 50 per cent, and coal at $7 per ton, the computed saving is about $1 per day.

We do not use a circulating pump upon these coils, although it might be advisable, especially if a larger system were used or one containing a number of bends between the coil and the hot-water tank. If the gravity-circulation system is used, the hot-water tank must, of course, be elevated above the boiler breeching, which condition would also be advisable if circulating pumps were used.

In case no hot water was being taken from the tank, the heat absorbed by the coils might raise the water of the tank to a temperature above that of the boiling point, in which case the safety valve would take care of any excess pressure. The higher the temperature of the tank the less heat will be absorbed by the coils, and the lower the temperature the more heat will be absorbed, so that the temperature of the tank automatically regulates itself to this extent.

Raleigh, N. C. R. M. ROTHGEB.

Aluminum as a Gasket Material

Pipe lines made up of sections joined by bolted flanges require a gasket of some yielding material between them to compensate for the slight expansion and contraction in the joint. Slight irregularities of the joined surfaces or alignment of the surfaces may be corrected by the gasket. One of the difficult conditions to be met by a gasket is in a steam line that is subject to varying pressures and temperatures ranging from a superheated condition to that of the atmosphere. Many materials will rapidly disintegrate under such treatment. Oil-line gaskets require a special material which will not be dissolved and contaminate the oil or rapidly disintegrate under the action of the oil. Leaky joints in pipe lines not only involve the loss of expensive materials, but the flanges are often scored by the escaping liquid or vapor as the case may be. The labor and perhaps the production delay incident to the replacement of one or more gaskets is often of great concern.

Considerable trouble was experienced in a 10,000-kw. steam plant some time ago with composition gaskets, due to the intermittent operation of the plant, which was in stand-by service to a hydro-electric system. Some time previously we had noted that a test steam line made up with aluminum gaskets had been subjected to a test of several hundred days, and during each day the steam pressure was raised to over 150 lb. for several hours and allowed to stand cold during the night. All gaskets in our steam plant have been replaced, as they showed signs of leakage, with aluminum rings made of 2SO aluminum. The designation 2S metal means commercially pure and the O represents zero in the scale of hardness or annealed dead soft. The rings were $\frac{1}{16}$ in. thick for lines of 8 in. diameter or less and $\frac{3}{32}$ in. for larger sizes of pipe, valve bonnets or other heavy work. The outside and inside diameters of these rings were made the same as if they were cut from sheet packing. Where a circle shear is available, they are cut from stock, otherwise they are cut by a machine shop.

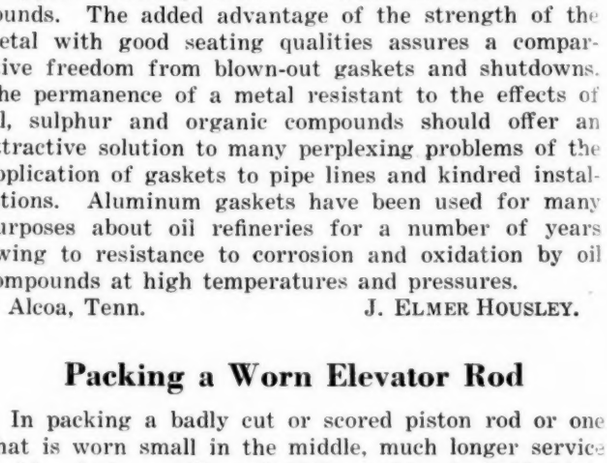
A rather unpleasant experience followed the previous use of a lead gasket on the oil-pressure line serving the step bearing of a vertical turbine. The lead gasket in the flange flowed under the continuous pressure of 1,200 lb. per sq.in. in the 2½-in. oil line and blew out with the loss of the step bearing and about 50 gal. of oil returned to the break by the pressure accumulator connected to the system. This gasket was replaced by $\frac{3}{32}$-in. thick aluminum and has shown no indication of leakage or distortion.

The annealed aluminum ring is soft enough to conform its surface to any ordinary irregularities in the faces of flange couplings due to the excessive stress existing at any high points or ridges in the face of the flange. When the surface has equalized, the metal is not under sufficient compression to cause any appreciable flowing of the gasket. Experience with repeated cycles of heating and cooling has indicated that very little permanent contraction takes place in the aluminum gasket. In one 14-in. line operating at 210 lb. steam pressure with 125 deg. F. superheat, after the line had cooled a large number of times, a small amount of weeping could be noticed at one gasket, but it always disappears entirely after the steam is raised a few pounds. The added advantage of the strength of the metal with good seating qualities assures a comparative freedom from blown-out gaskets and shutdowns. The permanence of a metal resistant to the effects of oil, sulphur and organic compounds should offer an attractive solution to many perplexing problems of the application of gaskets to pipe lines and kindred installations. Aluminum gaskets have been used for many purposes about oil refineries for a number of years owing to resistance to corrosion and oxidation by oil compounds at high temperatures and pressures.

Alcoa, Tenn. J. ELMER HOUSLEY.

Packing a Worn Elevator Rod

In packing a badly cut or scored piston rod or one that is worn small in the middle, much longer service and less leakage will result if the packing is divided into



Method of Packing Worn Plunger

three divisions. Fill in the first section with the customary cut rings. Then fill the center with a twisted roll of unbraided packing, wrapping it several turns around the rod. This makes a soft adjustable cushion that can be pulled down tight and made a constant snug fit to the rod. The remainder of the stuffing box should be filled with the usual packing. This method has kept hydraulic elevator rods tight and dry for several weeks at a time when the regular cut rings would be leaking in a few hours. It also works well on worn pump rods.

Sewickley, Pa. L. M. JOHNSON.

Comments from Readers

How To Get an Engineering Job

The contribution of H. M. Friend under the title "How To Get an Engineering Job" in the Jan. 18 issue is timely and of sufficient importance to warrant an extensive discussion and exchange of ideas based on individual experience.

The second introductory sentence of the contribution, "Much of engineering work is of necessity of a temporary nature," fortunately does not check with the writer's experience. Compared with other forms of employment, engineering positions are least subject to fluctuation. Industrial organizations, public utilities, common carriers, civil service, etc., where the bulk of technically trained men find employment, are of a more or less stable character. Even when affected by a temporary business depression, the reduction in the technical staff is last thought of. As a matter of fact, the period of reduced production is generally utilized for overhauling the existing equipment and the addition of new equipment, getting ready for the period of increased production that inevitably follows.

When the reduction in the technical staff becomes imperative, the usual policy is not to fill vacancies created by resignation, rather than to lay off men. Consulting engineering and contracting firms are continually after new business, and normally the tendency is to increase the technical force. Except in case of severe business depression, such as in August, 1914, the number of men looking for positions because the project they were connected with came to an end or standstill, is very small, indeed.

Unfortunately, a large percentage of technical men embark upon an engineering career with the intention of "setting the world afire," because of "the wonderful opportunities engineering offers." Upon entering industry, they are confronted with the cruel reality, for which they are unprepared. Impatient, disillusioned by the petty positions they have to fill, discouraged by the prospects, they invariably blame the organization they are with rather than the general scheme of things. It is this type of man, and not that thrown out of employment by necessity, that swells the ranks of engineering job-hunters.

The advice given by Mr. Friend in his introductory paragraph is superfluous and ill-considered. A "rolling stone" in the engineering profession does not even get the proverbial "polish." He starts at or near the bottom every time he changes his position and at the age of 35 or 40 he finds himself with his best years behind him and having progressed not far above the bottom of the ladder.

Neither do the statements contained in the second paragraph check with the writer's experience. Vacancies in good engineering positions are few and far between. When they occur, the number of applications from men out of employment as well as from men in fairly good positions but seeking immediate improvement, is bewildering. As a rule such positions are filled from the ranks, which is wise and just. When filled by outsiders, merit is not the only consideration.

The necessity for a middleman in bringing technically trained men in contact with possible employers has been questioned and made the subject of an exhaustive study by the Russell Sage Foundation. The result thus far published is not very flattering. Just how a man of average strength of will power can keep a stiff upper lip while facing the gloomy, hopeless atmosphere of the average employment-agency waiting room is not apparent. Perhaps it could be done.

The following experience of an engineering job-hunter is given for what it is worth. It is not intended to prove anything. Insufficient experiences have been recorded to warrant any general conclusions.

Having severed his connections with an industrial organization because of lack of opportunity and slow progress, he called on several agencies. He was given no encouragement. The expression on the faces of those about the waiting room seemed to corroborate the clerk's statement that "conditions at the present moment are hopeless."

Of some fifty applications in answer to announcements of vacancies in the publication of a certain semi-official employment agency, about ten were returned marked "received too late," although the applications were mailed within one hour from the receipt of the publication in which the announcement appeared.

Of seven replies to advertisers in the help wanted columns of technical magazines and a certain daily, three interviews were received. One interviewer remarked that the applicant's experience seemed to be mostly in the *operating* field, while he was looking for a man with more designing experience. He was willing, however, to try him at a salary 25 per cent less than what the applicant was asking. The second interviewer thought that the applicant's experience seemed to be *wholly designing*, while he needed a man with operating experience. Both men had identical carbon copies of the applicant's record before them.

The third interviewer remarked: "Your record shows only about six months' experience in my line, some ten years ago. However, you seem to have the proper background. I'll give you a chance."

Curiously enough, the applicant did not expect to get the job and asked for $50 per month more than in either of the other two applications for positions in lines in which he had 15 years' experience.

Sufficient time has elapsed to indicate that the applicant has made good. He has been given additional responsibilities and is in line for promotion, though perhaps not so soon as he expects.

Had the applicant filed his record with an employment agency, it would have never been forwarded to this particular or a similar firm, even if it had registered its wants with the agency. The "expert personnel psychologist" would have known that the applicant could not qualify.

E. OGUR.

New York City.

Welding Lugs on Electric Cables

The article by R. E. Kinkead in the March 1 issue was of particular interest. Although I may not agree with all he has to say regarding the welding of lugs to cables, this method seems to have some real possibilities, but will require a somewhat different construction of the lugs from that used for soldering. The illustration that Mr. Kinkead gives could hardly be classed in what is known as heavy current service, and the method he used no doubt served the purpose nicely.

The ordinary type of lug is made, as indicated in Fig. 1, with the shell thin at the bottom of the receptacle for the end of the cable. This has worked out satisfactorily, as the lug is soldered all the way around its receptacle to the cable. This allows the current to flow not only from the end of the cable into the lug but also from the entire periphery inside the receptacle.

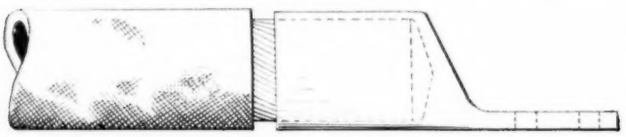


Fig.1

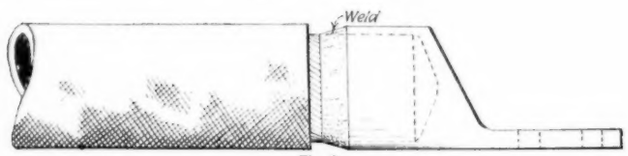


Fig.2

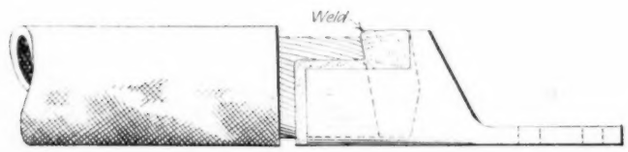


Fig.3

Figs. 1 to 3—Methods of connecting lugs to electric cables

This gives a fairly good current distribution from all parts of the receptacle into the bolted connection of the lug. When this type of lug is used for welding to large cables, one way of doing the job would be to use a lug with a short receptacle, as indicated in Fig. 2, and weld around the end as shown. To obtain a good hold on the cable will require that the weld be run back on the conductors, since practically all the current must be conducted into the lug through the weld. Of course a combination soldering and welding job could be done, by first soldering the lug to the cable and then welding it as indicated in Fig. 2.

Another method would be to cut off the top half of the lug's receptacle, as shown in Fig. 3, and weld the cable to the lug. In this case a large part of the current will flow from the end of the cable into the bottom of the lug. In this arrangement it will be necessary to provide sufficient metal to conduct the current from the end of the cable into the lug, and this can be obtained by having considerable space between the end of the cable and lug and filling in this space with welding metal, as indicated. It would also be a good idea to build up from the sides of the lug over the top of the cable with welding metal.

There is an opportunity in this practice for some interesting experiments, and there seems to be no reason why the work cannot be done better and at lower cost than by soldering, if a welding equipment is available.

Soldering of lugs on cables has always been an uncertain element in electric circuits. Experienced trouble men know of many cases where, after a period of service, the connections of lugs to the cables became so badly corroded that the circuit either opened up or an arc was established in the lug that badly damaged or burned the end of the cable off. If welding will insure a better and more secure connection than is obtained with soldering, it will be a welcome visitor.

Mr. Kinkead seems to be of the opinion that there may be cases where it would be desirable to have the lugs melt off the cables in case of heavy overloads. I would not care to be in proximity to a cable end that pulled out of a lug when 5,000 or 10,000 amperes was flowing in the circuit. If this happened on the back of a switchboard, I am afraid there would not be very much of the wiring left on the board, particularly if there was sufficient generator capacity to supply power into the fault. In my case I will take a chance on putting the lugs on to stay and let the damage be done where the fault occurs.

In regard to welding lugs on cables it would be interesting to know if this has been done to any extent around power plants and, if so, the methods used.

Philadelphia, Pa. C. O. MILLS.

Early Application of Air Preheaters

The information given by D. A. Manson in *Power*, Feb. 1, 1927, regarding the much earlier application of air preheaters in marine work than in stationary, is borne out by the number of ships fitted with Howden's forced draft, built just after the dates he gives, particularly from the early nineties onward. I have served as engineer on a number of ships built around that time, and this method of air preheating became almost a standard with passenger ships and the better class of freighters.

In the smaller ships one fan was used to feed a duct supplying all boilers. In others two or more fans were used, each supplying two or more boilers. The SS. "*Furnessia*" had one fan to each boiler.

In each case the system of heating the air was as described; that is, by leading the furnace gases through tubes in the air duct passing along the upper front of boiler. The size of these tubes was generally 4 in.

The air pressures were pretty close to those given. We used to try to keep 5 in. at the fan discharge, 3 in. in the duct to the ashpit, 1½ in. in the ashpit, and ½ in. over the fire.

The temperature of the stack was approximately 500 deg. F. when the fan was in operation, and when the fan was stopped and the boilers working natural draft, I have known the temperature of stack to rise to 750 deg. F. It was usual to take out the retarders when possible, if working with natural draft, as otherwise it was difficult to keep steam at all. The temperature of the air in the duct after heating was 200 to 220 deg. F.

The cost of upkeep was very low, as the ducts could be swept down from above at the same time the tubes in the boiler were punched, although it was a dirty job, usually done by the coal trimmers. As for material, the control-valve handles were the only replacement that was required.

I can bear out nearly all the other details given, although I never saw a better performance than 1½ lb. of coal per shaft horsepower, except for short periods, but even that was good at that time. This was obtained with almost any good coal—Welsh, Pocahontas, North of England, Scotch, even Japanese, would give a horsepower for but a fraction more, but the method of working the fires was different and the speed of fan varied some.

Another point was that the tubes in Scotch boilers built for Howden's forced draft were smaller than those built for natural draft, two and one-half inches as against three inches. T. HAMILTON.

Vancouver, B. C., Canada.

Some Uses for Thermometers

In reference to the use of thermometers for measurement of vacuum and to Mr. Harris' comments on my statement in *Power* of Feb. 8 that a well-placed thermometer is far more reliable for the measurement of vacuum than the usual mercury gage and barometer layout, I will add that several years' experience in official test work was the basis of the remark, and in the usual mercury gage and barometer layout I will include the usual layout for test purposes.

The thermometer used was of standard make, graduated for a 6-in. immersion, guaranteed to be correct to within one-half a scale division, and was used with thin brass wells. Considerable differences were found between the vacuum as measured with mercury gage and barometer and the corresponding indications of the thermometers, and we discarded thermometer readings in favor of those from mercury gages and barometers.

Then, because of unaccountable discrepancies, we began checking with thermometers again, and we found without exception that when the thermometer readings did not closely correspond with the corrected vacuum gage and barometer readings, there was something wrong with the mercury gage and barometer layout. Sometimes the error was in the calibrations.

I remember one occasion when a new power plant was undergoing an elaborate series of tests. The barometers, two in number, had been compared and checked by the local U. S. Weather Bureau and the mercury gages by a reputable testing laboratory. Corrections for mercury temperatures and scales, capillarity, etc., were all carefully made. We inserted a thermometer in the exhaust line. It indicated that they were reading the absolute pressure about one-quarter inch too low. The thermometer registered "superheat." We went over the mercury gage and barometer layout and finally found the errors there. One was due to a misunderstanding as to calibrations.

Such was one man's experience. Of course, the thermometers must be placed so that any dummy piston leakage, if the turbine is of the Parsons type, will not strike them, and far enough away so that steam seals will not affect them. If thermometers scaled for full immersion or at least 6-in. immersion are used, the conduction of heat from the hot end of the turbine or by radiation to the outside air will have negligible effect on the readings.

We once accounted for the superheat indicated by the thermometer by saying that the water in the exhaust steam had a temperature above the boiling point of water corresponding to the vacuum readings. When we got down to really fine points, we found that such was not the case, at least not for the type of turbine then under consideration.

Mr. Harris' observed error of 30 deg. for the electric resistance type of thermometer is by no means the record, but electrical thermometers are being made better and better.

For every-day plant operation I have found the standard recording type, such as made by several instrument manufacturers, to answer splendidly for checking condenser performance. These instruments will record the exhaust-steam temperature consistently year after year and by doing so place themselves far above the mercury gage and barometer readings as to reliability. I know of no good absolute pressure recording gage, but this is not to say that none exists.

A man's convictions are governed largely by his experience, and my experience has been that it is possible to locate thermometers so they will accurately respond to steam temperatures. Another argument in favor of the use of recording thermometers for the exhaust-steam is that temperature is a nearly direct measure of the value of the vacuum, because the steam consumption of condensing turbines changes proportionately with the changes of exhaust-steam temperatures. For the average condition this may be taken as one per cent increase in water rate for each ten degrees increase in exhaust-steam temperature. Then there is only one essential calculation, which can be made quickly, to find whether the condensers are up to standard, and that is to subtract the incoming circulating water temperature from the exhaust-steam temperature. These may be recorded on one chart. J. R. BELKNAP.

Charleston, W. Va.

Estimating Blowdown

Replying to the comment of J. C. Booser, in *Power* of Feb. 8, on the "Estimation of Blowdown," I can see only one way to estimate the quantity of water that enters the boiler through the automatic feed-water valves during blowdown. Let us assume that the water in the boiler is at normal level when blowdown is begun. When the water begins to drop, the feed-water valve automatically opens and remains open during the entire period. Then it is simply a matter of obtaining the approximate flow through the feed valve and adding this quantity for the period to the estimated blowdown. The values of flow or capacity of the feed-water valves could be obtained from the makers.

Of course the feed-water valves could be closed during the blowdown period, opening immediately upon completion of blowdown, but this would mean extra work for the water tenders. Without help it would be quite a task in a large boiler house.

A correction factor could be determined for the quantity of water that would flow during the short blowdown period, and regularly added to the estimated blowdown.

This quantity should be comparatively small, as the head on the feed water above that of the boiler is so much smaller than that between the boiler and the atmosphere, as exists at the blowdown valve. At the same time the size of feed line is much smaller than that of the combined blowdown valves. A small constant factor determined for the individual conditions would compensate roughly for this error.

Pittsburgh, Pa. J. D. JENKINS.

Are Hydro-Electric Installations Without Governors Justified?

SEVERAL plants have recently been installed in which governors for hydro-electric units, or at least sensitive speed control, have been omitted. Instead, means of slowly closing the wicket gates or the penstock valve ahead of the turbines have been employed. In such installations the control of the water entering the turbine may be by:

1. Wicket gates operated by a standard governor set to open and close at a predetermined slow rate.

2. Wicket gates operated by some form of hydraulic, mechanical or motor-driven device having a predetermined time element.

3. A valve or valves in the penstock ahead of the turbine set to operate in not less than a predetermined time. In this case the wicket gates would be stationary and would either replace or consist of extensions of the customary speed ring or stay vanes. From the foregoing, it is evident that in this case the turbine may operate at full gate opening only and, in case of dropping of load, will attain full runaway speed unless a satisfactory synchronous bypass or a shunt for the load is provided to hold the speed down until the gates or valve can be closed. In cases 1 and 2, the gate opening may be adjustable, but for any but small gate openings runaway speed may be attained if the load is suddenly cut off. The generator and turbine must, therefore, be designed to withstand safely any possible overspeed.

Idea Behind the Plans

The idea behind the adoption of either of these plans is to stop the column of water contained in the conduit feeding the turbine at such a slow rate as to minimize the resulting surge or pressure rise in the conduit to such an extent that the surge tank may be eliminated or the strength and thickness of the pipe line may be reduced, or both. With short water passages the inertia of the water column is small and hence the time of closing the gates or valve may be short enough to prevent serious overspeed. With long conduits a much longer closing time will be required for the gates or valves, in order to diminish the pressure rise to the extent mentioned, and in order to reduce the shock or impact on the mechanism and casing of the turbine the final closure should be very slow.

If the units are of relatively small capacity as compared to that of the connected system, they may be automatically thrown on the line and brought into synchronism from just below synchronous speed without seriously affecting the voltage and frequency of the system. Such an arrangement is therefore feasible for small automatic or semi-automatic stations.

Some hydraulic engineers are extremely skeptical of the proposal to reduce penstock thickness, etc., fearing that in operation the gates or valve might close more quickly than intended, owing to some defect in or accident to the mechanism, thus producing excessive surges or water hammer. The time required and the disturbance to voltage and frequency that may be caused in bringing a machine nearly into synchronism and then switching it into the system, are valid objections to such installations in the minds of many operators and executives. In any event voltage and frequency disturbances may be pronounced if the capacity of the units is large in comparison with that of the other units then in operation, and may be excessive for satisfactory operating conditions. Furthermore, more time will be required to synchronize such a unit than one provided with a standard governor, and this may prove to be a serious disadvantage. It is therefore a matter for each individual designer and his executives to decide, after careful study, whether such an installation is desirable under the operating conditions prevailing in a particular case. Where the control of water to a unit is by means of a valve, as described in 3, and the water supply is insufficient for continuous operation, such a unit or units will necessarily have to be operated at full load for part time only when the water and load are available.

A SUB-COMMITTEE[1] was appointed at the October, 1925, meeting of the Hydraulic Power Committee of the National Electric Light Association to investigate and report on various questions relating to hydraulic-turbine governors. A letter containing requests for answers to six questions was sent out to about fifty representative companies operating hydro-electric plants throughout the United States, from ten of which full replies have been received. In addition the questions were considered by the Hydraulic Power Committee of the Empire State Gas and Electric Association, and in November, 1926, additional questions were sent out to members of the Hydraulic Power Committee, as a result of which a number of additional replies were received. The following statements are compiled in a report by the committee from these communications, with some explanatory matter, and are believed to be fairly representative of existing opinion and practice.

[1]Chairman, Byron E. White, engineer, Utica Gas & Electric Co., Utica, N. Y.

Consideration should therefore be given to the question of whether a conventional governor or adjustable gate control, as in 1 or 2, should not be installed and blocked to use the available flow at part gate opening during the desired period of use.

The principal justification of this type of installation lies in the possibility of reducing the capital cost, thereby making some small projects economically feasible which otherwise would be too expensive to warrant development. Careful study of each individual project is essential in order to determine the possibility and extent of any saving that might be made. The elimination of or extremely slow timing of governors as previously described, is not feasible, from a satisfactory operating viewpoint, for a station from which a commercial load is being supplied and which station might be disconnected from the remainder of the system, thus leaving the frequency without control.

Cost of a Governor

The saving of cost by eliminating the governor or the sensitive speed-control feature, is so small (perhaps 10 per cent of the cost of the unit), that in practically no case except in an extremely small installation would it be a deciding factor by itself, in the economic feasibility of a project. In other words, there must be other incidental savings in cost of pipe lines, surge tanks, etc., if the money expenditure is to be an important deciding factor.

From the point of view of operation it is feasible and customary to operate a large proportion of the generating capacity of a system either on hand control or without sensitive governor control, leaving the governing to be done by one or, in any event, only a few of the more sensitive units. On one large system concerning which information is at hand, the governing is actually being done by units amounting to about 2½ per cent of the system capacity. On most systems a much larger percentage of the generating capacity would be required for this purpose.

The best efficiency of high-speed propeller type units is at or near full gate opening, but as the specific speed is lowered, the best efficiency occurs at lower gate openings. Hence in moderate and low specific speed units with fixed gate opening, larger runners and casings must be used in order that the point of best efficiency shall be approximately at full gate, thereby increasing the cost of the unit, although some alteration in design of the runner may be made to increase the power and bring the point of maximum efficiency nearer the customary full gate opening. In many cases the manufacturers might find it necessary to substitute new runners of modified design to meet power and efficiency guarantees under such

conditions, as the requirements would be more rigid than is ordinarily the case.

Conclusions

1. It is feasible to install units without sensitive speed control, provided:

a. They are so located that if disconnected from the system, they will not be required to feed any load.

b. They are of moderate aggregate capacity compared with the total generating capacity connected to the system at that time, say not over 25 per cent to 50 per cent of the operating capacity or connected operating load. Opinions vary as to this percentage, some companies believing that 50 per cent or more of the operating capacity may be operated without governors. In other words, if at a given time all units are provided with sensitive governors, additional capacity without governors or sensitive speed control might be added to the system, to the extent of 50 per cent to 100 per cent or more of the capacity of the governor-controlled units.

c. The units are designed to withstanding full runaway speed and are provided with means for opening the generator field circuit when overspeeded to a predetermined extent.

d. The operating requirements and standards of the system will permit of the time required for and the voltage and frequency disturbances likely to be caused by synchronizing and throwing on the line units of the designed capacity.

2. Since the cost of a complete governor is a small part of the cost of a development, its complete elimination or the substitution of other automatic means of closing the gates or valves will result in no appreciable saving in capital cost.

3. Unless the rate of closing of valves or gates is timed so as to limit positively to a small value, the resulting surge and final impact when the gate or valve closes, the elimination of the surge tank or reduction in pipe line thickness, or both, will be unwarranted and no saving in cost of the items will result.

Permanent Line and Level Marks in the Power Plants*

By H. M. Naylor
Kansas Power & Light Company,
Topeka, Kansas

SETTING permanent axis and bench marks has simplified the accurate setting of machinery, etc., in a large steam-driven power plant. Absence of any misalignment, except that due to inaccurate fabrication of materials, was a direct result.

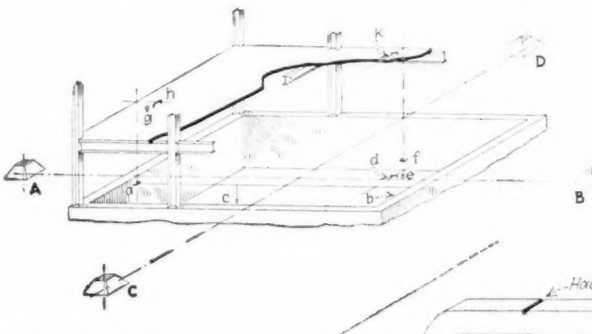


Fig. 1 (above)—Location of convenient monuments

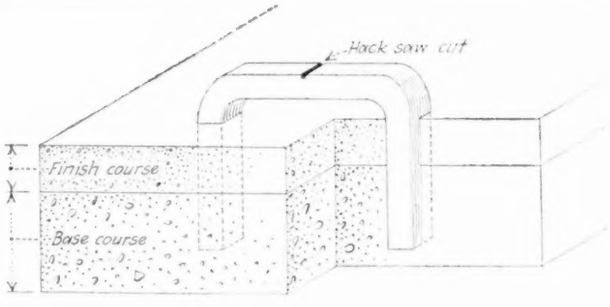


Fig. 2 (right)—Detail of chair for permanent alignment

The first step after completion of the drawings is to establish the axis line monuments *A*, *B*, *C* and *D*, Fig. 1, far enough away from the building site so that they will not obstruct building operations. The monument is best constructed of concrete with an iron or copper plate set flush and anchored with one or two bolts extending into the concrete. On smaller jobs it may consist of a 6-in. post hole 3 or 4 ft. deep with a short collar of stovepipe above the ground and the whole filled with concrete. On larger and more important works it is advisable to give the monument a spread footing. After the monuments are finished the axis lines should be established accurately and their positions centerpunched on the plate on each pier. Particular care should be taken that the intersection of the axis lines is as near as possible to 90 deg. The maximum allowable angular variation can be determined in terms of allowable linear variation at the extremities of the building.

As the construction progresses, these axis lines should be established within the building at all points and on all floors where necessary in the judgment of the engineer, as at *a*, *b*, *d*, *f*, *n* and *k*, etc., Fig. 1. These monuments may be made of any scrap piece of bar—usually a piece of reinforcing steel, either round or square and should be of not less than ¾-in stock. It is desirable to set these monuments roughly to line when the wall or base course of the floor slab is poured. If this is not possible, holes can be drilled with a star drill and the chair grouted in place. Care must be taken that the chair is set high enough to project above the finish course, see Fig. 2. After the concrete has set, the axis line should be located on the chairs with a transit and marked with a hacksaw, which gives a more definite and dependable mark than a triangular file. Fine wires can be tightly drawn through the saw cuts of adjacent chairs furnishing dependable means of accurately setting machinery and equipment.

Elevations can be handled similarly. A bench mark is desirable on each floor and can consist of a bolt or rivet set in a manner similar to the axis line chairs; or one end of one chair on each floor can be set slightly higher than the other, using the high end as the bench mark. The writer prefers the latter as it makes one less obstruction projecting from the floor.

*Abstracted from the *Engineering News-Record* for Feb. 10, 1927.

When boilers are taken out of service, certain precautions should be taken to prevent corrosion. They should be emptied and dried by means of a light wood fire. About 20 pounds of quicklime for each 1,000 sq.ft. of boiler surface should be placed on wooden trays in the interior of the boiler, after which all connections should be tightly sealed. Where the boilers are idle for a considerable period they should be opened every 3 months for examination and renewal of the lime. If water is left in idle boilers it should be made alkaline with caustic soda in excess of 50 grains per gallon and the water level should be raised up to the safety valve. The number of pounds of soda required equals the sq.ft. of boiler surface multiplied by 0.07. Caustic soda should be first dissolved and then added through the top main header into a full boiler of water, after which all openings and connections should be made tight. A piece of bright iron should be hung in the boiler in such a manner that it can be removed and inspected at regular intervals to determine whether or not the treatment is sufficient to stop corrosion.—F. N. Speller in *Mechanical Engineering*.

In a paper presented recently before the American Institute of Electrical Engineers, H. P. Sparkes told of a stroboscope method of calibrating watthour meters. In reality, this device is a wattmeter with a light vernier scale for measuring watt-seconds and giving instantaneous indications of meter speed. It measures watts with a high degree of precision, then transfers the measurement into a corresponding number of light impulses per second. The meter disk is calibrated in watt-seconds by means of marks placed on the circumferential edge of the disk. For calibrating the watthour meter the frequency of the light impulses is kept proportional to the meter load. Then if the meter is running at an incorrect speed, the markings on the disk will appear to move.

The Use of High-Pressure Steam in Marine Power Plants

Excerpts from a talk recently delivered before the Propeller Club of New York by H. L. Seward, Associate Professor of Mechanical Engineering, Sheffield Scientific School of Yale University.

MAN has made progress in the art of usefully applying the resources of nature by either of two methods—accidental ingenious discovery or carefully derived methods based on scientific analysis. The early savage discovered the uses of a sail on his canoe, but Flettner developed the rotor ship as an application of the Magnus theory from the laws of physics. Progress in steam engineering, while greatly dependent on experimentation, is even more dependent on scientific investigation at the present time.

At Niagara Falls the first water-power plants took advantage of only the sheer drop of 168 ft. available at the Falls; then it was noticed that there was an additional drop in the gorge below the Falls of 96 ft., and so a plant was built which could take advantage of this additional head. At a later date a third plant was built which could, in addition, take advantage of the drop of 50 ft. through the rapids above the Falls, thus operating with a total head of 314 ft. instead of the original 168 ft. There are some lessons for the steam power-plant man in these three stages of development. None of these three water-power plants differed essentially in the way they made use of the available energy, except in the refinements and niceties of design.

In a heat-power plant it is necessary that some energy be liberated and some vehicle be provided to convey the heat to a point where useful work may be done by expanding this vehicle. Since water has the highest capacity for carrying heat, it has long been used as a vehicle for heat in heat engines. It is a fundamental principle that all the heat should start from the greatest possible height and be given the maximum possible drop to the lowest possible level. If all the heat does not start at the highest level or if some of it escapes at a medium level, a loss occurs. Long ago it was noticed that whenever the final pressure of expanding steam was cut in half, the available power was doubled. Consequently, we increased our vacuum and tried to get down to the sea level on the scale of expansion. The steam turbine can effectively take advantage of these low back pressures and has been very successful in utilizing the drop "in the gorge below the Falls."

We are now wondering about the possibilities of getting something from the drop in the course of the "rapids above the Falls" of the heat scale. We soon find that the analogy between the waterfalls and our heat cycle becomes inadequate because we must definitely control that part of the operations involved in evaporating the ocean into clouds and rainfall finally running into Lake Erie, 575 ft. above the sea. We also note that the heat cycle has been somewhat complicated by schemes of regenerative feed-water heating which take steam from various stages of the turbine or engine in order to transfer heat to the boiler feed water. In some cases the steam is resuperheated after partial expansion and then returned for further expansion. We also hear of economizers and air preheaters.

Stationary Practice

There are power plants ashore operating at 1,200, 800, 700, 550, 462, 350 lb. and other "high pressures," so that we naturally wonder what is meant by the term "high pressure." We find that we are limited to a temperature of say 700 deg. F. to 750 deg. by the materials generally available for use in marine power plants. While man has in past ages found a way of overcoming such obstacles as are here presented in developing suitable materials to withstand higher temperatures than 725 deg., a substantial demand for such development and some research will be necessary. We shall find that we can accomplish considerable improvement in using the heat scale if we even now limit ourselves to this temperature on board ship. We may produce this temperature by innumerable combinations of pressure and superheat such as

Press., lb., abs.	Superheat, deg. F.
750	212
600	240
550	250

We also note that a pound weight of steam occupies just half as many cubic feet at the latter pressure and superheat as it does at 175 lb. gage, dry and saturated. It also contains 14 per cent more heat units per pound. Thus it is a much more compact and more crowded vehicle for heat.

One of the most comprehensive thermodynamic analyses of this whole subject was made by H. L. Guy before the British North Western Branch of the Institute of Mechanical Engineers and published in London *Engineering* last year. He shows that the advantages of bleeder feed-water heating and resuperheating are both a function of the initial steam pressure.[1]

Recent announcements in connection with the performance of S.S. "King George V," a channel steamer operating at 550 lb., give an over-all economy of 1.17 lb. coal, a value corresponding to 0.78 lb. of oil per shaft horsepower. We should be glad to have more data on the over-all cost of operating this plant, especially the investment charges. It can be shown that with this same pressure and with further refinements in design, the fuel rates should come down to 0.60 lb. of oil per shaft horsepower.

In considering the necessary equipment in a high-pressure marine steam plant we may well set up some ideal characteristics. Any seagoing power plant of ordinary size, in order to be operated to best advantage by ordinary human beings, must at least have the following characteristics:

(a) Must be almost infallible and absolutely reliable in operation;

(b) Must be easily operated and understood, in a confident manner, by available personnel;

(c) Must have such an initial cost as not to saddle the operation with prohibitive overhead cost;

(d) Must have a reasonably low operating cost, which, when added to overhead cost, makes the lowest cost per ton or per ton-mile;

(e) Must not be subject to extreme deterioration;

(f) Must burn fuels available on routes traversed.

The load on such a plant is much more steady than on our plants ashore, and so it would seem that it could be designed to take advantage of the best features of all auxiliaries and still not contain any untried gadgets. We need not think of the boiler as an exaggerated low-pressure boiler, but rather as a carefully designed grouping of heating surface, much smaller, placed scientifically around a furnace in which it is possible to so adjust matters as to liberate the maximum amount of heat energy. We must have flexibility in these adjustments, due to stop and slow bells, and we will probably not want any resuperheaters to complicate matters.

Our developments with powered coal look so promising now that it would appear that an ideal combination can be made with this form of furnace in a high-pressure steam maker. We would need several feed-water heaters in series, each with thermometers and gages so that the operating engineer can easily set these for the most economical results. This will be an operation with which he is entirely familiar.

The main steam line must be as short as possible and run only from the steam-maker to the prime mover and to the electric generating sets. As the volume of the steam is compressed one-half, both the steam-maker and all steam apparatus will be much smaller. As the turbine becomes more efficient,

[1] Professor Seward's summary of Mr. Guy's paper is of considerable interest, but is omitted here because the effects of higher pressures on total heat, thermal efficiency, etc., have already had considerable attention in these pages.—Editor.

there will be less heating surface required in the steam-maker.

The initial cost of such a steam-maker will be about equal to the cost of our present type of water-tube boiler operating at 250 lb., even with the addition of an air preheater or some feed-water heating surface in an economizer, one of which will be necessary in order to prevent our stack gases from leaving at too high a temperature. Every 40 per cent drop in stack temperature brings an additional one per cent in efficiency.

Careful control of the feed-water must be exercised, and the system must be kept tight and clean. Tradition had dictated for many years that we have an open feed and filter tank, but we should now consider a better plan of handling feed-water at this point in the cycle. All makeup water, even dock water, should be put through evaporators. These evaporators should receive their heat from turbine bleeding and can be worked into the general scheme of heat transfer in an economical manner. High-pressure plants ashore have successfully worked out this problem from a practical as well as a theoretical point of view.

All auxiliaries will probably be electrically operated by a few standardized sizes of motors, receiving power from an electric generating unit which contributes exhaust heat at the proper point in the heat scale to the feed-water. It is not desirable to lead high-pressure steam pipes all over the ship, when copper wires can be more profitably used.

A steam-driven feed pump and other steam units as stand-by equipment may be desirable. There are many methods proposed for bleeding auxiliary steam from the main turbine at suitable pressures, but these all depend on an automatic governor going into operation when the main unit is in maneuvering control. There is a profitable field of study in connection with mechanically driven auxiliaries so connected to the main unit that an automatic shift-over to electric drive is made during maneuvering. Where heavy deck machinery loads are to be served, as in Lake ore carriers, a high-pressure electric drive plant throughout can be built which really operates much like a central power station ashore.

While one naturally thinks first of a steam turbine as the prime mover, the one reliable piece of apparatus in the older types of plant is the reciprocating steam engine. When carefully designed, it holds a record for unit economy. It has more chance of being useful at high pressures than at extremely low pressures. Mechanically it is understood by all our personnel and should not be overlooked in this connection. We shall, however, have some difficult problems in design to meet in connection with metal expansion and lubrication if we go to higher pressures.

We have trained our personnel in new types of equipment, sent them to sea knowing full well that their ingenuity and resourcefulness would somehow overcome almost insuperable difficulties and then wondered why the upkeep or repair bills were so heavy. We must take advantage of all accumulated engineering experience to the fullest possible degree, and it would seem that in high-pressure steam there is not so much that is new and terrifying to the average available personnel. Operating engineers ashore report no difficulties with such apparatus as safety valves, stop valves, flange welded joints, insulation, superheaters, economizers and other parts of the plant where one might expect that design might have been slighted because of more enthusiasm directed at the main units. A well engineered job is thoroughly attainable in high-pressure steam marine plants if advantage is taken of experience gained ashore.

It is high time that there be an opportunity to gather operating records on over-all costs of a medium-sized marine power plant with high-pressure steam. The initial cost of the whole plant would appear to be from 50 to 65 per cent of the initial cost of a Diesel direct-connected plant and but little more than present steam plants. The possibilities of economy in fuel costs seem attractive if the plant is carefully designed. More operating personnel are available for this type than for any other type of plant. Only after a few years' experience in actual operating service shall we be able to say whether or not we have, for the time being, discovered "the one best way."

Alternating-Current Elevator Motor Drive*

The alternating-current motor used today for high-speed passenger-elevator service represents the result of the accumulated experience of the last fifteen years. The motor must have more than one speed, and these speeds must be practically constant whether the machine is running as a motor or is driven as a generator. The induction-type alternating-current motor is the only one that has been found suitable for elevator service, giving a positive multi-speed control. The slip-ring type of induction multi-speed motor was preferred until about 1919, when the multi-speed high-resistance squirrel-cage motor came into favor.

Past experiences gave a basis for arriving at what was essential for a motor in order to produce what would be considered a satisfactory alternating-current elevator for all service and speeds. Tests indicated that, so far as known, the single stator with two independent windings and a high-resistance squirrel-cage rotor fulfilled more of the requirements than any other type. The more important of these requirements are:

First, it must be practical to manufacture motors of at least 6:1 speed ratio and still have machines of suitable size to install on the elevator machine. So far as known, 3:1 ratio was the maximum for slip-ring type motors. Squirrel-cage motors of from 25 to 150 hp. with a 6:1 speed ratio have been in regular elevator service for over five years.

Secondly, the motor must be as small as possible, especially the rotor. This is necessary in order to keep the rotor's inertia at a minimum and allow rapid acceleration and retardation with a minimum of power consumption and starting current.

Thirdly, it must be possible to design a motor sufficiently quiet in operation to allow its use in hospitals, hotels, apartments, office buildings and private residences.

Fourthly, the motor must allow torque characteristic changes at the installation. This is necessary because it is practically impossible to determine the exact requirements in advance, and if it were possible, it would be impractical to design a motor for each application. These changes can be made in either the slip-ring or squirrel-cage motors after the general motor characteristic requirements are known.

Fifthly, the motor must allow a smooth and positive control of speeds, whether accelerating or retarding, and still not require an excessive number of switches or a complicated and expensive type of controller.

Sixthly, all sliding and exposed contacts should be avoided. This is essential because of the operating conditions and requirements. It is a generally recognized fact that the squirrel-cage type of motor is the most reliable.

Seventhly, the motor must have sufficient radiation to permit the handling of maximum elevator service without abnormal temperature rise. This is one of the most important problems of design in connection with high-resistance squirrel-cage motors for elevator service. It is possible to change the heating of a motor on elevator service a large amount by changing its characteristics. It should also be recognized that standard commercial motor parts cannot be adapted to all elevator service. One of the most important facts to consider when designing a motor for elevator service is that its average running speed is usually less than one-half its full rated speed. This results in less than one-fourth the volume of air that a constant-running motor would have. And, last, its radiating surface must be carefully considered.

Eighthly, it is very important to have a relatively high running and starting power factor. The reason for this is to reduce to a minimum the power-line disturbance when starting or lifting maximum loads.

Ninthly, a motor should be capable of producing the maximum starting torque that is practical to obtain with given mechanical dimensions. This is necessary in keeping the inertia at a minimum and increasing the acceleration and retardation efficiency.

Tenthly, the motor should produce the maximum practical torque per ampere in starting. This means that it should produce the maximum starting torque obtainable without increasing the frame size. This is also necessary to obtain the most efficient acceleration and retardation. In this connection attention is called to the fact that it is more important to have efficient acceleration and retardation than efficient full speed operation in order to obtain the most economical elevator service.

*Abstract from a paper, by E. B. Thurston, presented at the Winter Convention, American Institute of Electrical Engineers, New York City.

News in the Field of Power

Urges Senate Investigate Power Control by Utilities—Walsh Resolution

Would Authorize Committee of Five Members of Senate Empowered to Examine Corporate Operations—Could Subpoena Witnesses—Present Support Small

A RESOLUTION designed to authorize the appointment of a special committee of the Senate to investigate the control of power resources by public utility corporations and to recommend legislation for the amelioration of any evils which the committee may find to exist has been introduced by Senator Walsh, democrat, of Montana.

The resolution went over for future consideration after an attempt by Senator Walsh to have it referred to the Committee to Audit and Control the Contingent Expenses of the Senate had been blocked by objections based on the ground that it should first be considered by the Committee on Commerce.

FIVE MEMBERS RECOMMENDED

The full text of the resolution reads:

Resolved, That a committee of five members of the Senate be appointed by the President thereof hereby empowered and directed to inquire into the growth of the capitalization of public utility corporations supplying either electrical energy in the form of power or light or both, however produced, or gas, natural or artificial, and of corporations holding the stocks of such corporations, the method of issuing and the price realized or value received for the various security issues of both classes of corporations named, including the bonds and other evidences of indebtedness thereof as well as the stocks of the same, the extent to which additions or extensions to the property of the operating companies have been made, and the value or detriment to the public of holding companies owning the stock or otherwise controlling such operating companies immediately or remotely, with the extent of such ownership or control, and particularly what legislation, if any, should be enacted by Congress to correct any abuses that may exist in the organization or operation of such companies.

WOULD SUBPOENA WITNESSES

The chairman of the committee, or any member thereof, may administer oaths to witnesses and sign subpœnaes for witnesses; and every person duly summoned before said committee, or any subcommittee thereof, who refuses or fails to obey the process of said committee or appears and refuses to answer questions pertinent to said investigation shall be punished as prescribed by law. The expenses of said investigation shall be paid from the contingent fund of the Senate on vouchers of the committee or subcommittee, signed by the chairman and approved by the Committee to Audit and Control the Contingent Expenses of the Senate.

The committee or any subcommittee thereof is authorized to sit during the sessions or the recesses of the Senate, and after the expiration of the present Congress until the assembling of the Seventieth Congress, and until otherwise ordered by the Senate.

SENATE NOT ALARMED

The fact that Senator Walsh received the support of only six members of the Senate in his effort to prevent the confirmation of A. F. Myers, of Iowa, to be a member of the Federal Trade Commission, gives some indication that the Senate does not share his apprehension as to the sinister intentions of large units in the business world.

Action on Electrical Bills Unlikely as Congress Dies

There seems little prospect that Congress will take affirmative action on any of the pending legislation of interest to the electrical industry.

A vote on the Walsh resolution, proposing an investigation of the entire public utility industry, is improbable.

The Norris resolution providing for a period of government operation at Muscle Shoals is opposed and probably cannot be passed, even if the existing filibuster should be broken.

Even Senator Shortridge's resolution to provide $1,000,000 for the protection of the lower Colorado River against floods seems to be in danger. On the House side the Military Affairs subcommittee is about to give out a report summarizing its investigation and expressing certain conclusions.

The Interstate and Foreign Commerce Committee reported favorably the bill instructing the Federal Power Commission to grant no rights on the upper Tennessee. Secretary Davis already had given assurances to the Military Affairs Committee that he, as a member of the Federal Power Commission, would not vote for the granting of any rights on that stream.

Texas University Installs Largest Stoker Units

The new boiler plant of the University of Texas at Austin, will contain what is said to be the largest stoker units ever built.

Three of these units, now nearing completion at the shops of McClave-Brooks Co., Scranton, Pa., will be double units 12 ft. wide and 10 ft. 10½ in. deep. Two single units for the same installation, also under construction, will be 7 ft. 3 in. wide by 10 ft. 10½ in. deep.

Picks Combustion Engineers for Smoke Nuisance Fight

Nine expert combustion engineers were invited by Health Commissioner Harris March 2 to serve on a committee to aid the department in its endeavor to eliminate dense smoke from the atmosphere of the city. At the same time he expressed the opinion that jail sentences for smoke ordinance violators would soon rid the city of the nuisance. To the engineers he wrote:

"I am confronted with various intricate and highly technical problems of furnace operation in large industrial establishments. I do not wish to visit any hardship upon industry. Certain persistent violators of the ordinance forbidding the emission of dense smoke make the claim that they cannot remedy the situation. I am therefore anxious to secure the advice of experts in determining the proper attitude to adopt in the enforcement of the law."

Those asked to serve are Dr. Calvin Rice, secretary of the American Society of Mechanical Engineers; C. E. Davies, managing editor, *Mechanical Engineering;* J. V. Davies, Prof. Charles E. Lucke, Dwight P. Robinson, P. H. Carey, Prof. George F. Bateman, Cooper Union; Prof. William J. Moore, Polytechnic Institute, Brooklyn, and F. R. Wadleigh.

Dr. Harris said the power houses of the Interborough and the Edison companies, as well as those of other public-utility corporations, continually violated Section 211 of the Sanitary Code, which prohibits the emission of dense smoke.

New York Refrigerating Men Hold Meeting

The second meeting held during 1927 of the New York section of the American Society of Refrigerating Engineers took place Feb. 23, at the Machinery Club, 50 Church St., New York City.

President Bennis introduced the speaker of the evening, William W. Brush, chief engineer of the Department of Water Supply, Gas and Electricity of the City of New York, who presented a very interesting paper entitled "Interesting Phases of New York City's Water Supply. Mr. Brush, with the aid of excellent lantern slides, showed the general system of Catskill Water Supply to New York City.

Public Ownership Pays Large Profits in California

Success of municipally controlled public utilities was seen in a recent report by Ray L. Riley, state controller of California, that not one failure occurred in that state in the operation of municipal enterprises during the last fiscal year.

The municipally owned water and electric systems, operated by 172 California cities, showed net profits of $7,172,542.08, according to the Riley report. Municipally operated water plants in 150 cities alone returned total receipts of $13,696,991.70. Operating expenditures were $7,489,493.11. After the deduction of $3,701,036.66 to provide for bond redemption and interest payments, net receipts of $3,506,461.93 remained. Electric systems operated by 22 municipalities reported total receipts of $12,986,083.33. With deduction of operating expenses and bond and interest payments, a net profit of $3,666,080.15 was had.

Other municipal enterprises which reported profits were gas plants, wharves, docks and landings. The combined profits were $8,509,566.30.

N.E.L.A. Announces Forbes Public Relations Contest

Announcement of the third annual *Forbes Magazine* Prize Contest, to award the most constructive public relations campaign carried on by a light and power company in a local territory during the past year, has been made by the National Electric Light Association.

Data submitted for competition should embrace the plan of campaign employed and its method of conduct, exhibits of all types of advertising and literature used, a record of achievement as indicated by customer ownership results, increased use of appliances, and increased sales of light and power, and data indicating growth of good will.

All exhibits and papers must be in the *Forbes Magazine* offices, 120 Fifth Avenue, New York, on or before April 20, the day the contest closes. *Forbes Magazine* proposes to make the award at the N. E. L. A. convention in Atlantic City, June 6.

Ottawa River Project Rights Bone of Contention

A merry fight is brewing in Canadian Parliamentary circles over power-development rights on the Ottawa River, which forms the boundary line between the provinces of Ontario and Quebec.

Principal interest centers in what is known as the Carillon water-power site. With a potential power development of 300,000 hp. this important site, within 35 miles of Montreal, near Point Fortune on the main line of the Canadian Pacific Railway, is proving a magnet to enterprising men with large capital. The question of the right to use the site was brought before the Federal House of Commons recently when the government tabled three orders-in-council covering legal phases in the effort on the part of important interests to establish their rights.

The original lease of this site was granted to the National Hydro Co. of Montreal, under date of July 14, 1913, and has since been renewed. In 1926 the Conservative Ministry extended the lease, calling for commencement of the construction by Dec. 1, 1927. The order-in-council was cancelled by the Liberal Government, which stipulated that work should begin by May 1, 1927, failing which, the right to use the site will lapse. In the meantime the Montreal, Ottawa & Georgian Bay Canal Co. has made application to Parliament for an extension of its charter, which, it is believed, would entitle the company to rights at Carillon.

A Tenth of a Thousandth of a Millionth of an Ampere!

An instrument that indicates a change in current as small as a tenth of a thousandth of a millionth part of an ampere has been developed in the standardizing laboratory of the West Lynn works of the General Electric Co. as a part of the equipment which replaces the human eye in making tests on incandescent lamps, currents in insulators, radio tubes, etc.

The instrument, known as a thermionic microammeter, has a full-scale reading of a tenth of a millionth of an ampere, with subdivisions of one five-hundredth of this amount. It is the most sensitive instrument of such a long-scale length working on jewel bearings that has ever been built.

The usual 40-watt Mazda lamp, which consumes less than one-half cent's worth of electricity an hour, uses 2,000,000,000 times as much current as the amount represented by one subdivision on the scale of this instrument.

Boulder Dam Bill May Pass Next Session

To disinterested parliamentary observers it is very apparent that the Boulder Dam bill in its present form will have no more chance to pass at the next session of Congress than it had at this session.

For that reason, it is believed that California will be willing to make concessions which it was unwilling to consider before the failure of the desperate effort to put this legislation through Congress at the session just closed. Negotiations already are on foot looking to informal conferences among representatives from the various states and of the private interests concerned. None will be surprised to see some practical compromise worked out during the interim between session of Congress.

There also is the possibility that an expert committee, drawn from the executive departments concerned, may be set up to make a recommendation on the development of the Colorado River.

Opposes Drilling of Boiler Heads and Shells

At a recent meeting of the Ohio Board of Boiler Rules, of the Division of Boiler Inspection, attention was directed to the tendency on the part of builders of water screens and water cooled bridge walls to make connections to drum heads of boilers for downcomers and riser pipes. The heads of these boilers, especially those already in service, are not of the proper thickness to take care of the plate removal necessary for these openings, and in the opinion of the Board this construction creates a dangerous condition.

On motion of Mr. Connelly, seconded by Mr. Vance, it was unanimously ruled that this construction is not acceptable to the Board, and the Division of Boiler Inspection, was requested to send out a circular letter to boiler inspection companies, boiler manufacturers, and manufacturers of water cooled walls, calling their attention to this condition.

Connections of this kind must be made to the boiler shells unless the heads are increased to the required thickness adequate for the plate removed, it was agreed.

Museum of Peaceful Arts Gets $80,000 and Headquarters

At a board of directors meeting, March 2, plans discussed for the establishment of the Museum of Peaceful Arts included an appropriation of $80,000 toward the undertaking, and the announcement that the headquarters of the project will shortly occupy offices in the Scientific American Building, 24 West 40th St., New York City.

It is expected that an official statement regarding substantial progress will be made at an early date.

Issues Conditions of Lincoln Arc Welding Prizes

An official statement of the conditions governing the award of the Lincoln arc welding prizes for 1927 has been issued in bulletin form by the American Society of Mechanical Engineers, for the special use and benefit of prospective contestants. Copies may be had at the headquarters of the Society, 29 West 39th St., New York City.

The American Society of Mechanical Engineers has accepted the custody of $17,500 offered by the Lincoln Electric Co., of Cleveland, Ohio, to be awarded by the society in the world-wide competition for the best three papers disclosing advancement in the art of arc welding presented under the rules of the competition set forth by the official statement now issued.

Armstrong Steam Trap Men Hold Banquet

Officials of the Armstrong Machine Works of Three Rivers, Mich., manufacturers of the Armstrong steam trap, and forty-five factory representatives from all parts of the United States and Canada made the Chicago Power Show the occasion for a get-together, meeting and banquet at the Hotel Morrison in Chicago, Feb. 15.

Obituary

Albert Ball, chief mechanical engineer of the Sullivan Machinery Co. for nearly fifty years, died at his home in Claremont, N. H., Feb. 7, at the age of 91 years and 9 months. In 1868 Mr. Ball became associated with the Sullivan Machinery Co., and remained with that concern until his retirement in 1914.

Personal Mention

Gen. Otto H. Falk, president of the Allis-Chalmers Manufacturing Co., is in Cuba.

D. K. Swartout, president of the Swartout Co., sailed on a Mediterranean cruise March 5.

William M. White, who is chief engineer of the Allis-Chalmers Manufacturing Co., is now on his way to Japan.

Luke C. Bradley has severed his connections with the Stone & Webster, Inc., organization to accept the position of president of Rhode Island Public Service Co. and director and member of executive committee of New England Power Association.

T. G. Bradley has been appointed general superintendent of the California Oregon Power Co., a newly created position, with headquarters at Medford, Oregon, according to P. O. Crawford, vice-president and general manager of the company. Mr. Bradley has been with the company and its predecessors for twenty-eight years.

Orestes H. Caldwell, editor of *Electrical Merchandising* and *Radio Retailing*, member of the American Institute of Electrical Engineers, the radio committee of the American Engineering Council, and director of the New York Electrical Board of Trade, has been nominated by President Coolidge to membership on the Federal Board of Radio Control.

Joseph G. Worker has been appointed general sales manager and elected to the board of directors by the American Engineering Co. of Philadelphia, Pa., as marking the beginning of extensive plans for marketing the Taylor stoker, Lo-Hed electric hoists, Juruick commercial refrigeration units for restaurants, golf clubs, etc., and the A-E-CO line of fine yacht, ship and cargo-handling machinery. Mr. Worker assumes his new duties with more than 20 years' experience in engineering and sales work and an intimate knowledge of the products and policies of the American Engineering Co., acquired during the last five years as assistant to the president of that company. A graduate of the University of Illinois, he is a member of the American Society of Mechanical Engineers, a former president of the Stoker Manufacturers' Association and is widely known as a writer of articles on combustion engineering and co-author of a work on mechanical stokers.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Kansas City, Mo. regional meeting March 17-18, Bethlehem, Pa. regional meeting April 21-23, Pittsfield, Mass. regional meeting May 25-27. Summer convention at Detroit, Mich., June 20-24 inclusive; Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Oil Burner Association. Annual convention and exposition at Buffalo, N. Y., April 5-7, inclusive; C. F. Olmstead, 350 Madison Ave., New York City.

American Refractories Institute. Spring meeting at Hotel Traymore, Atlantic City, N. J., May 18-19; D. A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh, Pa.

American Society of Civil Engineers. George T. Seabury, secretary; Spring convention at Asheville, N. C., April 20-22. Annual convention at Denver, Col. July 13-15.

American Society of Mechanical Engineers. Spring meeting at White Sulphur Springs, W. Va., May 23-26. Calvin W. Rice, secretary. Midwest regional meeting will be held in Kansas City, April 4-6 inclusive; F. S. Dewey, chairman of the Kansas City Section.

American Society of Refrigerating Engineers. Western meeting at White Sulphur Springs, W. Va., May 23-25, in conjunction with the Spring meeting of the A.S.M.E.; W. H. Ross, secretary, 35 Warren St., New York City.

American Water Works Association. W. M. Niesley, assistant secretary, 170 Broadway, N. Y. Annual convention Hotel Sherman, Chicago, June 6-11.

American Welding Society. Annual meeting at 29 West 39th St., New York City, April 27-28-29.

Association of Iron and Steel Electrical Engineers. Annual convention in conjunction with Iron and steel exposition at Pittsburgh, Pa., June 13-18, inclusive.

Heating and Ventilating Exposition. Will be held at Twelfth Regiment Armory, New York City, March 14-19 inclusive.

National Association of Practical Refrigerating Engineers. Annual convention probably in November; E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention, in conjunction with the Pacific Coast Power Show, will be held at the Ambassador Hotel, Los Angeles, Calif., Aug. 22-27 inclusive, John Topman, secretary, convention committee, Ohio State annual convention in Memorial Hall, Lima, Ohio, June 16-18, inclusive, in conjunction with the Northwestern Ohio Power Show; P. H. Grigsby, secretary of convention committee, Lima, Ohio. New England States convention at Portland, Me., June 17-18. Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass. Indiana State convention at Anderson, May 27-28; George S. Billman, secretary.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., during second week of June.

National District Heating Association. Annual convention at West Baden Springs, West Baden, Ind. May 17-20; D. L. Gaskill, secretary, Greenville, Ohio.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Feb. 28 1927
Pool 1	New York	$2.75@$3.25
Smokeless	Boston	1.88
Clearfield	Boston	1.45@ 2.00
Somerset	Boston	1.75@ 2.10
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.65@ 1.90
Pittsburgh	Pittsburgh	1.80@ 1.90
Pittsburgh gas slack	Pittsburgh	1.40@ 1.50
Franklin, Ill.	Chicago	2.50@ 2.75
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.40@ 2.50
West Ky.	Louisville	1.30@ 1.65
S. E. Ky.	Louisville	1.50@ 1.85
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.75@ 3.50
Buckwheat No. 1.	Philadelphia	2.75@ 3.75
Birdseye	New York	2.00

FUEL OIL

New York—Mar. 3, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Feb. 21, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 6.25c. per gal.; 38@40 deg., 7c. per gal.

Pittsburgh—Feb. 23, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6.75c. per gal.

Philadelphia—Feb. 24, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.90@$1.96 per bbl.

Cincinnati—Feb. 28, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6¼c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Feb. 28, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.27½ per bbl.; 26@30 deg., $1.35; 30@32 deg. $1.65.

Boston—Feb. 28, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.85c. per gal.; 28@32 deg., 6c. per gal.

Dallas—Feb. 26, f.o.b. local refinery, 26@30 deg., $1.75 per bbl.

Press Bulletin Series No. 7, devoted to Illinois petroleum, will soon be issued from the press by the State Geological Survey at Urbana, Ill. The first paper in this number of *Illinois Petroleum* gives a brief report on the oil possibilities of a structure in southwestern Adams County which recent field work has located. The second paper summarizes developments in the Illinois oil and gas fields during 1926 and compares them with the results of 1924 and 1925. The prospects of oil and gas production in the State during 1927 are also discussed. As long as copies are available, they may be secured for 25 cents by addressing the Chief, State Geological Survey, Urbana, Ill.

Business Notes

J. Blakeborough & Sons, Ltd., Brighouse, England, have just been awarded the contract for the supply of the valve equipment in connection with the Nippon Electric Power Co.'s development at Komaki on the Sho River, Japan.

James L. Mayer announces the opening of a sales office with Fred E. Oswald for industrial-engineering equipment at 332 South LaSalle St., Chicago, Ill. He represents manufacturers of pressed-steel overhead conveyor wheels, trolleys and casters.

The Climax Engineering Co., Clinton, Iowa, has just completed arrangements with the Koehring Co. Associates, 50 Church St., New York City, to handle the sale of Climax engines, power units, and accessories for export exclusively in Argentina, Colombia, Italy, Panama, India, Philippine Islands and Japan.

The Falk Corp., announces the election of Arthur Simonson as a vice-president. Mr. Simonson was for some years general foundry superintendent of the William Wharton, Jr., & Co., Inc., Philadelphia, Pa. He has been connected since 1910 with the Falk Corp. in various capacities in the steel foundry, and as sales manager of the steel foundry department since the year 1916.

The Brown Instrument Co., Philadelphia, Pa., has appointed L. C. Wilson to handle sales and engineering service in connection with the distribution of the Brown electric flow meter in Pittsburgh territory.

Trade Catalogs

Worm Gear Speed Reducers—The Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill., has issued an illustrated catalog, No. 300, devoted to its IXL "Hygrade" worm gear speed reducers.

Packings, Reversible Ratchets, etc.—Greene, Tweed & Co., manufacturers, 109 Duane St., New York City. The selection of piston-rod packing, asbestos, the value of lubricant in rod packings, friction, economy rings and reversible ratchets are the topics of "Economy," the title of this small but well-illustrated booklet.

Autovalve Lightning Arresters—The Westinghouse Electric & Manufacturing Co. has issued leaflets L. 20013-H and L. 20149-C, the first describing the application, operation and distinctive characteristics of the LV Autovalve arrester and the second leaflet discussing the SV Autovalve type. These leaflets may be obtained at any of the district offices of the Westinghouse company or at the publicity department at East Pittsburgh, Pa.

High-Pressure Valves—H. L. Mason, 66 Victoria St., London, S.W.1, England. Mason's new system of high-pressure stop valves is the subject of this illustrated bulletin. These valves have a positive closure; they regulate with minute accuracy and are not subject to wiredrawing. They can be adjusted, repaired or completely renewed while under pressure if necessary, so that, in the event of a serious leak occurring, the valve can receive attention without having to be isolated.

Automatic Temperature Control—The Sargo Co., Inc., 183 Madison Ave., New York City, has issued a pamphlet entitled "The Widening Field of Temperature Control," by Joseph A. Maguire, consulting engineer to the company. This booklet of seven pages considers the matter of temperature regulation in heating and the various industrial processes where the solution of this problem is of the greatest importance. Copies may be obtained from the company by those who are interested in the subject.

New Plant Construction

Ark., Marianna—City Comrs., O. C. Sutton, Pres., will receive bids until Mar. 10 for waterworks improvements including reservoir, filter plant, pumping station, fire and deep well pumps, circulating pumps, etc., for Waterworks Improvements Dist. No. 2. Estimated cost $100,000. T. H. Allen, 840 Bank of Commerce & Trust Bldg., Memphis, Tenn., is engineer.

Calif., Los Angeles—J. Oviatt, c/o Walker & Eisen, Western Pacific Bldg., Archts., plans the construction of a 12 story office and stores building including steam heating system, 4 elevators, etc. on South Olive St.

Calif., Salinas—Salinas Cold Storage & Ice Co., will build an ice plant by day labor. Estimated cost $150,000. LaFever Engineering Co., 545 2nd St., San Francisco, is engineer.

Calif., Santa Monica—Mutual Shares Properties Inc., c/o M. E. Durfee, Commission Exchange Bldg., Los Angeles, Archt., is having plans prepared for the construction of a 12 story office and stores building including steam heating system, electric elevators, etc., on Santa Monica Blvd. here. Estimated cost $500,000.

Fla., Jacksonville—Albany Hotel Apartments, Inc., is having plans prepared for the construction of a 21 story apartment building including steam heating, cooling, and circulating ice water systems, etc., at Ocean and Monroe Sts. Estimated cost $3,000,000. R. A. Benjamin, Bisbee Bldg., is architect.

Ill., Chicago—Chicago Bd. of Trade, 141 West Jackson Blvd., is having preliminary sketches made for the construction of a 43 story office building on West Jackson Blvd., Sherman, LaSalle and West Van Buren Sts. Holabird & Roche, 104 South Michigan Ave., are architects.

Ill., Chicago—Syndicate, c/o Levy & Klein, 111 West Washington St., Archts., will soon receive bids for the construction of a 12 story apartment and stores building including central refrigeration plant at Kenmere and Bryn Mawr Aves. Estimated cost $1,100,000.

Ill., Chicago—United Artists Corp., 729 7th Ave., New York, N. Y., is having plans prepared for the construction of a theatre building including cooling plant, etc. at Randolph and Dearborn Sts. here. Estimated cost $500,000. C. H. Bettis and C. H. Crane, 32 West Randolph St., Chicago, Ill., are architects.

Ind., Terre Haute—Terre Haute Hotel Co., is having revised plans prepared and will take bids in March for the construction of a 10 story hotel. Estimated cost $1,000,000. W. E. Russ, Meridan Life Bldg., is architect. Seventh St. Hotel Co., A. R. Pick, Pres., Chicago, Ill., is lessee.

Ind., Valparaiso—City, F. E. Kenny, Clk., is having plans prepared for waterworks improvements including reservoir, pumping station, etc. Estimated cost $200,000. A. R. Putnam, City Hall, is engineer.

Ia., Cedar Rapids—Cedar Rapids Orpheum Building Corp., c/o A. Frank, Frank Amusement Co., Inc., Waterloo, will receive bids about Mar. 15 for the construction of a theatre, office and stores building including steam heating system at Third Ave. and Third St. Estimated cost $1,200,000. W. P. Whitney, 122 South Michigan Ave., Chicago, Ill., is architect.

Ia., Clarion—City is having preliminary plans prepared for waterworks improvements including 130 ft. deep well, pumping equipment, etc. Estimated cost $15,000.

La., Minden—Minden Cotton Oil & Ice Co., J. B. Snell, Gen. Mgr., will build a 25 ton ice plant by day labor. Estimated cost $50,000.

Mass., Boston—Edison Electric Illuminating Co., 70 State St., will receive bids until Mar. 10 for the construction of a power plant at Arch and Hawley Sts.

Minn., Duluth—City, C. P. Phillips, Comr., City Hall, will receive bids until Mar. 16 for the construction of a city hall building including central heating plant, etc., at First St. and 4th Ave. W. Estimated cost $750,000. T. J. Shefchik, 313 Glencoe Bldg., is architect and engineer.

Minn., Marshall—City, A. G. Bumford, Clk., is having plans prepared for the construction of a power plant. Estimated cost including equipment $100,000. Pillsbury Engineering Co., 2344 Nicollet Ave., is engineer.

Minn., Minneapolis—Minneapolis Mfg. Co., E Hennepin and 5th Ave., E. E., is having plans prepared for the construction of a power plant at 2300 East Hennepin Ave. Estimated cost $50,000 including 600 hp. boiler and equipment. Pillsbury Engineering Co., 2344 Nicollet Ave., is engineer.

Mo., Jefferson City—Missouri State Highway Dept., is having preliminary plans prepared for the construction of an office building including steam heating system. Estimated cost $500,000.

Neb., Fremont—City Water & Light Comrs., H. L. Burrell, Comr., will receive bids until Mar. 15 for the construction of a 46 x 109 ft. addition to power plant, etc. Estimated cost $90,000. Burns & McDonnell, Interstate Bldg., Kansas City, Md., are engineers.

N. Y., Baldwin, L. I.—L. Frankel, c/o H. J. Krapp, 1 West 47th St., New York, Archt., will build a 6 story theatre and apartment building including steam heating system on Grand Ave., here. Estimated cost $900,000. Work will be done by separate contracts under the supervision of the architect.

N. Y., New York—Durham Realty Corp., J. C. Thorn, Pres., 511 5th Ave., is having plans prepared for the construction of an 18 story addition to hotel including steam heating system, elevators, etc., at 5th Ave. and 55th St. Estimated cost $1,500,000. Schultze & Weaver, 17 East 49th St., are architects.

N. Y., New York—Bronx Eye & Ear Infirmary, 459 East 41st St., is having plans prepared for the construction of a hospital including steam heating system at

Grand Concourse and McClellan St. Estimated cost $700,000. Starrett & Van Vleck, 393 7th Ave., are architects.

N. Y., New York—Hawxhurst Realty Co., W. Wheelock, Pres., c/o Kohn, Butler, Stein & Vilolo, 56 West 45th St., Archts., will soon receive bids for the construction of a 22 story office building including steam heating system, elevators, etc., at 18-22 East 48th St. Estimated cost $700,000.

N. Y., New York—Supt. of Standards and Purchase, Executive Dept., Albany, N. Y., will receive bids until Mar. 10 for the installation of a refrigeration unit in New York House of Refuge, Randall's Island here.

O., Chagrin Falls—Bd. of Education, H. B. Pugsley, Clk., awarded contract for the construction of a central heating plant, to H. A. Cotlner. Estimated cost $17,250. Contract for boilers, stokers, etc., awarded.

O., Cleveland—Canfield Oil Co., M. C. Dippel, Purch. Agt., 3216 East 55th St., will soon award contract for the construction of a boiler house on East 52nd St. Estimated cost $40,000. T. Maynz, c/o owner, is engineer.

O., Columbus—Dept. of Welfare, J. E. Harper, Dir., Ninth and Oak Sts., will receive bids until Mar 24 for the construction of a power house for Deaf and Dumb Institution at East Tower St. Estimated cost $55,000.

Pa., Philadelphia—Dept. of City Transit, H. E. Ehlers, Dir., 1211 Chestnut St., will receive bids until Mar. 15 for the construction of sub-stations at Mt. Vernon and Lemon Sts. for housing synchronous converters and auxiliary apparatus for operation of portion of Broad St. and Ridge Ave. subway. Private plans.

Pa., Pittsburgh — North Side Laundry Co., Winifred and Success Sts., is having plans prepared for the construction of a boiler house, etc. Estimated cost $40,000.

South Carolina—Lexington Water Power Co., Columbia, T. C. Williams, Pres., subsidiary of the General Gas & Electric Co., W. S. Barstow, Pres., 50 Pine St., New York, N. Y., will build a hydro-electric plant, 200,000 hp. on Saluda River, 10 miles west of Columbia, dam 1¼ mi. long, 188 ft. high, 1,200 ft. thickness in mid-section, lake created to be over 30 miles long. Estimated cost approximately $20,000,000. Murray & Floyd, Grand Central Terminal, New York, N. Y., are engineers. Construction work to be done by W. S. Barstow Management Asso., Inc., 50 Pine St., New York, N. Y.

Texas—M. G. Clymer Co. and Bert Clymer Co., 425 West Davis St., St. Louis, Mo., plans the construction of a system of preserving plants at various cities, one central plant and smaller plants will be established at probably Alvin, Dickinson and Webster, Tex. Main plant in 2 units, 80 x 300 and 60 x 300 ft. including boiler and engine room outside. Estimated cost $2,000,000. Private plans.

Tex., Houston — Houston Lighting & Power Co., F. Gibler, plans to expend $4,730,700 for extensions and improvements during 1927 including West End sub-station. $130,000 Magnolia Park sub-station $300,000, North Side sub-station, $325,000 transmission lines $359,500, also installation of transformers, etc. $65,000. Construction work will be done by Texas Construction Co., Electric Bldg.

Tex., San Antonio—Blue Bonnet Hotels and A. H. Shafer Estates, 418 North St. will receive bids about Mar. 15 for the construction of a 12 story hotel including steam heating and ventilation systems, elevators, etc., at Pecan and St. Mary Sts. Estimated cost $500,000. P. G. Silber & Co., 331 Bedell Bldg., are architects.

Ont., Ottawa—Canadian National Rys., Montreal, Que., will soon receive bids for the construction of a hotel on Rideau St. here. Estimated cost $4,000,000. C. S. Gzowski, is chief engineer.

Ont., Toronto—Loblaw Groceterias Ltd, 1385 Bloor St. W., plans the construction of a warehouse including steam heating system, elevators, etc. Estimated cost $500,000. Architect and engineer not selected.

Ont., Toronto—Toronto General Hospital, 101 College St., plans the construction of a group of hospital buildings including power house, etc., at University Ave. and College St. Estimated cost $2,500,000. Darling & Pearson, 2 Leader Lane, are architects.

Ont., Toronto—Yolles & Rotenberg, Federal Bldg., will build a 12 story office building at Bay and Albert Sts. Estimated cost $500,000. Steam heating system, elevators, etc., will be installed. Owner is general contractor.

Equipment Wanted

Boiler and Motor, etc.—Laval Construction Co., Ltd., 4740 Iberville St., Montreal, Que., is in the market for a 25 hp. steam boiler and 10 hp. electric motor, etc.

Boilers—Bd. of Education, W. W. Pearse, 155 College St., Toronto, Ont., will receive bids until Mar. 9 for two 50 hp. horizontal return tubular steam boilers.

Boilers and Motors—W. H. Rawleigh Co., Ltd., 135 Richelieu St., Montreal, Que., is in the market for two 150 hp. steam boilers and fifteen 125 hp. electric motors.

Coal Handling and Unloading Equipment, etc.—P. W. Wayne, Engr. of Newton Milling & Elevator Co., Newton, Kan., is in the market for pulverized coal burning, coal handling and unloading equipment, etc., for 350 hp. plant.

Converter, Transformer, etc. — Dept. of Public Works, Wellington, N. Z., is in the market for rotary converter, induction voltage regulator, transformer, circuit breaker, arc rectifiers, starting switches, switchboard and connecting cables.

Engine and Generator—City of Water Valley, Miss., had preliminary plans prepared for the installation of a new 300 hp. Diesel engine and generator in water and light plant. Estimated cost $40,000. Engineer not announced.

Ice Plant Machinery — Texas Power & Light Co., Llano, Tex., will be in the market for machinery for proposed addition to ice plant to increase the capacity 5 ton daily. Estimated cost $15,000. Private plans.

Motors — St. Thomas City Diary, St. Thomas, Ont., is in the market for five 5 hp. electric motors, 1,500 r.p.m., 25 cycle, 550 v.

Motors—Thorp Hamerock Co., Ltd., Park Ave., Montreal, Que., is in the market for three 20 hp. electric motors.

Power Machinery and Piping—U. S. Engineer Office, War Dept., Washington, D. C., will receive bids until Mar. 22 for furnishing and installing machinery and piping in power house and turbine pit at Lock and Dam 47 Louisville, Ky. on the Ohio River.

Pump—James Irrigation Dist., A. F. C. Greene, Secy., San Joaquin, Calif., will receive bids until Mar. 23 for one screw head pump to operate under 5 to 9 ft. head, capacity 15 sec.ft., direct connected to a 440 v., 60 cycle, 40 deg., 450 to 600 r.p.m. motor and automatic starter. H. M. Crocker, is engineer.

Pump, Motor, etc. — W. J. Richardson, City Water Supt., Orange, Tex., plans to purchase a deep well pump, electric motor, etc., for well No. 4. Estimated cost $5,000.

Pumps—City Comrs., O. C. Sufton, Pres., Marianna, Ark., will receive bids until Mar. 10 for fire and deep well pumps, circulating pumps, etc., for waterworks Improvement Dist. No. 2.

Pumps—Z. E. Booe, Mayor and Comrs., Bunnell, Fla., will receive bids until Mar. 28 for two 700 g.p.m., one 400 g.p.m. centrifugal pumps and one 250 g.p.m. motor driven suction force pump, etc. for proposed waterworks system.

Pumps—P. E. Lewis, Mayor and City Council, Franklin, Ky., will receive bids until Mar. 15 for three 1,000,000 gal. and one 3,000,000 gal. motor driven centrifugal pumps, etc., for proposed waterworks improvements. Klyce & Harrub, 708 Fourth and First National Bank Bldg., Nashville, Tenn., are engineers.

Pumps—L. P. Gregory, Clk., Superior, Neb., will receive bids until Mar. 21 for a 750 g.p.m. single stage, 1,750 r.p.m. centrifugal pump against 265 ft. head, connected to 75 hp., 3 ph., 60 cycle, 2,200 v., 1,750 r.p.m. squirrel cage motor complete with hand operated starting compensator; Alt. 1 includes double squirrel cage motor without hand operated compensator; Alt. 2 slip ring motor with hand operated compensator; Alt. 3, 2 stage centrifugal pump with squirrel cage motor with hand operated compensator; Alt. 4, 2 stage pump connected to double squirrel cage motor without hand operated compensator; Alt. 5, 2 stage pump connected to slip ring motor with hand operated compensator; Alt. 6, single stage pump, 3,450 r.p.m., connected to 3,450 r.p.m. squirrel cage motor with hand operated compensator; Alt. 7, single stage 3,450 r.p.m. pump connected to 3,450 r.p.m. double squirrel cage motor without hand operated compensator. Henningson Engineering Co., National Bldg., Omaha, Neb. is engineer.

Pumps, etc.—City Council, Crystal Lake, Ill., will receive bids until Mar. 15 for 900 g.p.m. motor driven deep well pump, centrifugal booster or fire pump with motor, etc. for proposed waterworks improvements. Randolph-Perkins Co., 1444 First National Bank Bldg., Chicago, Ill., is engineer.

Pumps, Motors—City, L. E. Boles, Clk., Randolph, Kan., will receive bids until Mar. 10, for deep well pump, motor, tank on tower, etc., for proposed waterworks improvements. Estimated cost $30,000. W. B. Rollins & Co., 521 Railway Exchange Bldg., Kansas City, Mo., are engineers.

Refrigerator Unit—Dept. of Welfare, J. E. Harper, Dir., Ninth and Oak Sts., Columbus, O., is receiving bids for a large compressor type refrigerator unit for Phychological Hospital, Bureau of Juvenile Research, West Broad St.

Stoker — Bd. of Purchase, H. C. Cain, Secy., City Hall, Columbus, O. is in the market for a mechanical forced draft underfeed type stoker for 1,000 hp. boiler at municipal light plant.

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PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

DECLINING tendencies still appear in the market for power plant and electrical supplies, although not to such a marked degree as existed at this time last month. Minor items, such as linseed oil and cotton waste are cheaper, while flexible cord in 250-ft. coils dropped 4 per cent from the Feb. 8 level. Minimum quotation on structural rivets at Pittsburgh is up 10c. per 100 lb., compared with a month ago; the rise, however, has not affected boiler rivets. Highest grade babbitt metal is up 4c. per lb., while fabricated brass and copper products experienced a ½c. per lb. decline during the last week.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 68c. per ft.
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	50%

Air—Best grade

¼-in., per ft.	3-ply, $0.34	4-ply	$0.42	

Steam—Discounts from List

First grade	40%	Second grade	40–5%	Third grade 50%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%	Second grade	50–10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40–5%
Heavy	30–10%

RAWHIDE LACING—For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$1.05
Asbestos for high-pressure steam, ⅛ in.	1.85
Duck and rubber for piston packing	1.05
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.95
Wire insertion asbestos sheet	1.40
Rubber sheet	.60
Rubber sheet, wire insertion	.85
Rubber sheet, duck insertion	.65
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72½%
	2-ply	74%

PORTLAND CEMENT—New York, $2.35@$2.50 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	13.00@17.50	16.00	15.00@20.00
Colored	9.00@13.00	12.00	12.00@17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows.

Chicago	$0.15
New York	.17½
Cleveland (per thousand)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.84	$0.98	$0.80

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$15.25	$15.25	$16.75	$16.75
White	15.25	15.25	15.25	15.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, ⅞x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ¾-in. dia., 35c.; ⅝-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, per 100 lb.:

New York	$4.20	Chicago	$3.50	Pittsburgh	$2.40@$2.60

Cone-head boiler rivets, per 100 lb.:

New York	$4.40	Chicago	$3.70	Pittsburgh	$2.90

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern	net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	26@29
Magnesite brick: 9-in. straights	net ton	65.00
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50
Magnesite brick: Soaps and splits	per ton	91.00
Silica brick: N. Y. Union, Pa.	per M	45.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@45
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	38@40
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	38@40
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	38@40
Chrome ore crude, 40@50%	net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	88.00
Commercial genuine, intermediate grade	61.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	13.25

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.00	$3.90	$3.60
Flats and squares, per 100 lb. base	4.50	4.40	4.10

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
⅛ to 3	62	50½	⅛ to 1½	30	12

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

⅛ to 1½	60	49½	⅛ to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38 00	17 92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25 50	42 50	27 04
3¼	30 25	49 50	30 67
3½	31 50	52 75	33 33
4	38 03	67 00	40 11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.
These prices are net per 100 ft. based on stock lengths. If cut to special engths, billing will be based on the entire stock lengths.
In addition to the above, standard cutting charges are as follows:
2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3½ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$31.00 (net)	$50.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615 00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	20%
Coils to 1,000 ft	60%	30%
1,000 to 5,000 ft	62%	35%
5,000 ft. and over	65%	38%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56 50	$61 34	$7 76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10 21	11.63	6.46	7.03
1	103 31	113 00	15 10	17.21	8.39	9.13
1¼	139.77	152 88	20 51	23 07	11.78	12.75
1½	167.12	182 79	27 34	30.76	14.56	15.75
2	224 83	245 94	50 13	56 40	19 41	21 01
2½	355 50	388 85	82 03	92 28	27.73	30 01
3	464 88	508 50	218.74	246 10	41 59	45.01
3½	585 30	637 74	483 04	543.46	55.46	60.02
4	714 17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$17.75
No. 16 cotton reinforced heavy	22.00
No. 18 cotton reinforced light	14.50
No. 16 cotton reinforced light	18.35
No. 18 cotton Canvasite cord	14.75
No. 16 cotton Canvasite cord	17.20
No. 16 super service cord or similar (2 wire) in 1,000 ft	$82.28	*90.50
No. 14 super service cord or similar (2 wire) in 1,000 ft	121.00	*133.10

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 64%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4 00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.75
0-30 ampere, less than standard package	3.00

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard A type bulbs:

100—130 Volt Watts	Type	Price Each	200—260 Volt Watts	Type	Price Each
15	A 17	$0.25	Special		
General			25	A 19	$0.30
25	A 19	.25	50	A 21	.30
40	A 21	.25	100	A 23	.53
50	A 21	.27			
60	A 21	.30			
100	A 23	.43			

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6 00	$9.10	$10 90	$17.40
12	9.90	12 60	14 60	23.80
10	13.20	16 40	18 60	30 50
8	19.00	22.30	24 20	42.40
6	.....	.....	34 40	.....
4	.....	.....	48 00	.....
2	.....	.....	68 75	.....
1	.....	.....	94 70	.....
0	.....	.....	115 00	.....
00	.....	.....	138 00	.....
000	.....	.....	165 00	.....
0000	.....	.....	196 00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.17	$0.15	$0.22	$0.20	$0.18	$0.25
Unbroken carton	.18	.16	.23	.22	.19	.26
Broken carton	.20	.18	.25	.24	.21	.28

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 33c. lb.; 100 lb. lots	31c lb.
Rubber tape, ¾ in., less 100 lb. 35c. lb.; 100 lb. lots	33c lb.
Wire solder, less 100 lb. 33c. lb., 100 lb. lots	31c lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50 0 list value	30-5%
$50.00 list value or over	35%